

Hundred New Isotopes

# CHEMISTRY



<b>A Hundred New Radioisotopes</b>	1
<b>Year of Isotopes</b>	5
<b>Atomic Power Engineering</b>	8
<b>Back Cover Picture:</b>	
<b>Five-Pointed Fission Stars</b>	16
<b>World Congress of Chemistry</b>	17
<b>For the Home Lab:</b>	
<b>Hot-Headed Halogens IV—Fluorine</b>	26
<b>Patent Story of the Month</b>	29
<b>Brush-off For Bristles</b>	33
<b>Things To Do:</b>	
<b>See Your Own Voice</b>	35
<b>Oil From Shale Demonstrated</b>	37
<b>Classics of Chemistry:</b>	
<b>Gallium and Scandium</b>	38
<b>Chemical Relief for Hay Fever</b>	45
<b>Editorial:</b>	
<b>The Usefulness of Isotopes</b>	
<b>Inside Front Cover</b>	

OHIO STATE  
UNIVERSITY  
SEP 3 1947  
LIBRARY

25¢

## The Usefulness of Isotopes

► NOT MANY MONTHS ago isotopes were very strange things without much practical use other than to clutter up the pages of scientific journals and confuse the unwary layman.

Now you may begin to encounter a non-chemist who will use the word "isotope" as intelligently as he allows "fission" to sputter forth in his worrisome questions about the fate of the world and atomic energy.

It is beginning to be unnecessary to describe isotopes as atomic twins or triplets or quadruplets or quintuplets or whatever more there are to multiple births.

How far the little isotopes have radiated themselves into our research is shown by the relatively big business that the Atomic Energy Commission makes of producing and distributing them. Transitory ones made in the atomic piles get high air priority the way generals did in the war. Isotopes, some of them, live much shorter lives than generals, although others will be frittering themselves away centuries after their man-makers have turned to dust. Then, as the readers of CHEMISTRY well know, there are many isotopes that are not radioactive at all and are distinguished by their heftiness and not their blowing-up.

The manufacture in the largest of all cyclotrons, as told in this issue of CHEMISTRY, of isotopes on the lighter side of most of the elements, promises to give scientists a whole array of new tools.

But even with the ones that are already available there is much probing into secrets. Viruses are being tagged, cancer cells are being marked indelibly, the intricacies of a chemical reaction are being understood by making one source of an element identifiable from another.

It is all a very modern demonstration that little things do amount to something and that slight differences are useful in this world.

---

### CHEMISTRY

---

Vol. 20, No.12

Formerly The Chemistry Leaflet

August 1947

#### Including The Science Leaflet

Published monthly by Science Service, Inc., the institution for the popularization of science. Publication Office: 119 South Frazier St., State College, Pa. Entered as second-class matter at the Post Office. State College, Pa., under Act of Congress of March 3, 1879. Address communications to Editorial and Subscription Office: 1719 N St. N.W., Washington 6, D.C.


25c a Copy. \$2.50 a Year. Two-Year Subscription \$4; Your Own and a Gift Subscription \$4. Quantity Subscriptions, 10 or more copies to same address: \$1.70 a Year, \$1 for any seven months, 15c each Copy each Month. No charge for Foreign or Canadian Postage.

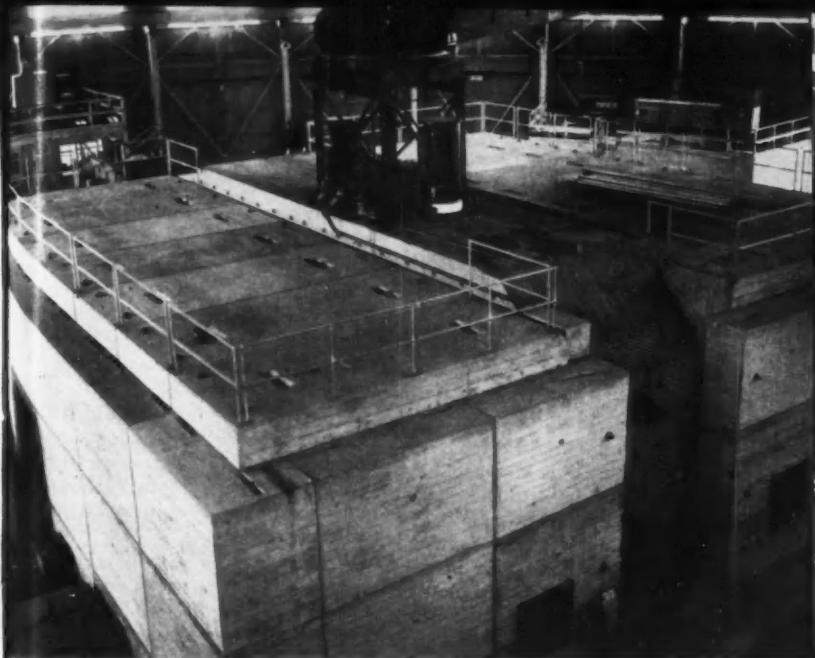
Editors: WATSON DAVIS and HELEN MILES DAVIS

Consulting Editor: PAULINE BERRY MACK (Editor 1927-1944)

Copyright 1947 by Science Service, Inc. All rights reserved. Science Service issues press service for newspapers and magazines, publishes Science News Letter (weekly), issues THINGS of Science (monthly) and administers Science Clubs of America.

Science Service is the educational and scientific institution organized in 1921 as a non-profit corporation with trustees nominated by the National Academy of Sciences, the National Research Council, the American Association for the Advancement of Science, the E. W. Scripps Estate and the Journalistic Profession.





► IN THE WORLD'S largest cyclotron at Berkley, Calif., hidden by this sarcophagus of concrete, atomic hearts or nuclei have been smashed more thoroughly than ever before, with possibly 30 particles being produced from one atom and transmutations 16 steps downward.

## A Hundred New Radioisotopes

► THE SUCCESSFUL operation of the 184-inch cyclotron of the University of California at Berkeley has brought transmutations of atomic nuclei more extensive than occur even in the atomic bomb.

The 4,000 ton nuclear destroyer has knocked 22 and possibly as many as 30 particles out of an atomic heart or nucleus. A hundred or more new radioisotopes are in prospect, elements

have been transmuted 16 steps down the periodic table and a host of new highly complex problems posed for scientists.

Beams of 200,000,000 electron-volt deuterons and 400,000,000 electron-volt helium ions have made this possible.

Research sponsored by the Atomic Energy Commission as part of its peacetime program was reported at

AUGUST 1947

CHEMISTRY HALL LIBRARY

the Pacific Coast section of the American Physical Society by Drs. Glenn T. Seaborg and Isadore Perlman, who were aided by Drs. B. B. Cunningham, H. H. Hopkins, Manfred Lindner, D. R. Miller, P. R. O'Conner, R. C. Thompson.

Two or three particles are the usual number knocked out by prewar cyclotrons. In a sample bombardment, arsenic, which is element number 75, was transmuted down to cobalt 54. When results can be studied more closely, the scientists may find 30 particles dislodged.

An entirely new series of 100 or more radioisotopes of common elements which are lighter than stable isotopes is opened up by these bombardments. This is a greater number than resulted from the fission in the atomic bomb, which produced mostly isotopes heavier than the stable isotope of elements. In fission, nuclei are overbalanced with neutrons and such nuclei tend to decay up from the stable isotope. Iodine fission isotopes included iodine 131 and higher, while stable iodine is 127.

Few lighter isotopes were produced formerly. The new higher voltage bombardments create transmutation products tending to be overbalanced with protons after removal of any neutrons. Such nuclei stabilize by converting protons into neutrons and, in losing charge, decay downward.

## Cyclotron's Concrete Sarcophagus

► THE GIANT new cyclotron at the University of California is now "buried" in a five-foot-thick sarcophagus of concrete which absorbs the dangerous radiation created during its operation.

For example: A new light isotope is iron 52 produced from the bombardment of copper. Previously no isotope of iron lighter than the stable isotope 54 had been produced.

Many new isotopes useful for tracers for purposes not now existing may result.

As many as 30 different radioisotopes were created in one bombardment, some new, some familiar. Different rates of decay make identification highly complex.

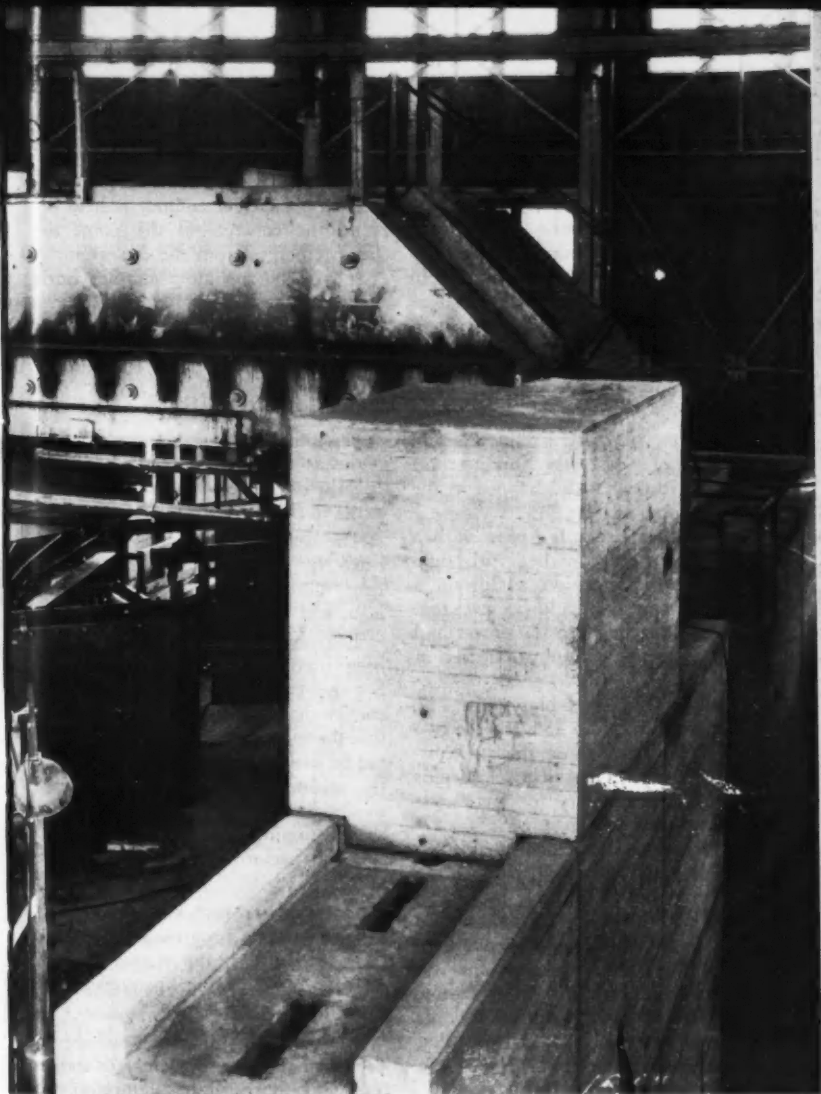
In one case arsenic bombarded by alpha particles or helium hearts produced chlorine, 16 steps down the periodic table. Prewar cyclotrons transmuted elements up or down one or two elements.

With the simpler patterns of lower energy range, transmutation routes almost always can be predicted. But the new leap down the periodic table opens up alternative routes, primarily because several charged particles are knocked out. Scientists must now set to work on a new set of principles to predict new phenomena.

The fission of uranium with deuterons and alpha particles was also reported. This resulted in a wider spread of fission products than with slow neutrons, and a more symmetrical splitting with the fission products bunched in the center of the periodic table.

As the intensity of the 100,000,000 electron-volt neutron beam is increased the thickness of the wall will be doubled. Of all the substances tested, including water, paraffin, graphite, aluminum, lead and copper, only the





► MASSIVE WALLS which shield the surroundings from the radioactivity within may have to be made even thicker as the rate of fission builds up.

AUGUST 1947

latter was more effective than concrete. However, copper was impractical because of the expense.

The five-foot wall cuts the intensity of the neutron beam down to one hundredth its original strength, which is sufficient protection against the present intensity of the beam, according to Dr. B. J. Meyer, physicist in the Radiation Laboratory.

The cyclotron's sarcophagus is composed of 98 concrete blocks, averaging

20 tons each and totaling about 2000 tons. Its dimensions are 20 feet high, 65 feet long, and 55 feet wide.

The neutron beam is so powerful, however, that it can be detected faintly when a Geiger counter is held behind the concrete at the point the beam emerges from the cyclotron.

The 4,000 ton atom-smasher hurls atomic projectiles of 10 times greater energy than any previous heavy particle accelerator.

## More Fissionable Elements

► ONE OF THE GREATEST questions in atomic energy since the Smyth report revealed just what did happen in the atomic bomb is this:

Will other elements fission with a release of energy, either with sufficient neutron emission to sustain a chain reaction or at a lower level that would allow their use for slower and therefore more peaceful production of energy?

Uranium 235 and plutonium 239, made from uranium 238, are the two atomic elements, those that will fission explosively, producing a surplus of neutrons necessary for an almost instantaneous chain reaction.

Thorium is an element that must be kept under control in any scheme of atomic energy control, because it turns into fissionable uranium 233 when mixed with a more active neutron emitter, such as uranium 235 and plutonium. It can keep the atomic energy piles going because it emits one neutron for each neutron that smacks into it effectively, but it can not be used in atomic bombs itself.

The element, protoactinium, that lies between thorium and uranium,

is presumably fissionable, but it hardly needs to be considered practically because of the very small amount that exists in the world.

The heaviest metals occurring in any quantity, below the naturally occurring radioactive ones, are bismuth, lead, and thallium.

The new California cyclotron has been used to fission these elements, but this can be done only with high energy deuterons and alpha particles, that do not occur in nature. They cannot be fissioned with slow neutrons in the manner of the atomic bomb elements. More energy must be put into their fissioning than can be gotten out and the performance is not self-sustaining.

So far as present knowledge and experiment has progressed, the relatively plentiful heavy elements hold no hope for economical conversion of mass into energy.

The world is still under the necessity of giving attention only to uranium and thorium in attempting to exert human control over the use of atomic energy.

**Medical and Plant Life Secrets  
Unlocked by Atomic By-Products**

## A Year of Isotopes

► IN THE SINGLE year since the first shipment of radioactive isotope chemicals produced in the atomic pile at the Clinton Laboratories, Oak Ridge, Tenn., the following atomic advances in medicine are reported by the Atomic Energy Commission:

1. Discovery of a better treatment for congestive heart failure. This resulted from the finding, by Dr. George E. Burch of Tulane University School of Medicine, that in patients with this heart condition sodium as well as water escapes from the blood vessels into the tissues. Because sodium is a "thirsty" element, water follows the sodium out of the blood vessels. This results in the dropsy of congestive heart failure. As a result of these studies with tagged atoms of sodium, patients are now given medicines to eliminate the excess sodium as well as the excess water in their tissues.

2. Treatment of chronic forms of leukemia, lymphoma and Hodgkin's disease with radio-gold, which has turned out to be "exceedingly useful" in these conditions.

3. Development of methods for learning more about how cancers are produced through the use of a cancer-producing chemical methylcholanthrene, tagged with radioactive carbon 14.

4. Quantitative measurements of blood circulation with red blood cells tagged with radiophosphorus which showed conclusively that in heart disease when heart arteries are clogged

(coronary thrombosis) other blood vessels take over the job of the blocked ones.

5. Successful treatment of patients with overactive thyroid glands, too sick for surgical removal of the gland, with radioactive iodine which has also been used to attack cancer of the thyroid.

6. Discovery of new knowledge for fighting anemia through use of radio-iron which appears in the red blood cells and shows the rate at which these cells are made and how iron is absorbed and utilized in the body.

7. Tagging of penicilin and other drugs to learn more of how they stop or kill germs in the body and, perhaps, how to develop more effective drugs.

### Sugar Formation Shown

► ADVANCES have been made possible by isotopes in other fields. Sugar formed in one leaf of a large sugarcane plant during one hour's work in the sun was distributed to all parts of the 11-foot, seven-pound stalk within three days. This hitherto unsuspected fact of plant life was demonstrated through the use of carbon atoms "tagged" with radioactivity at the Clinton Laboratories atomic pile here and sent to Honolulu for research purposes.

In the Honolulu laboratories of the Hawaiian Sugar Planters' Association, Dr. George O. Burr and his co-workers combined the radioactive carbon with oxygen to make carbon dioxide.

This "tagged" CO<sub>2</sub> they fed to one leaf of a large sugarcane plant for one hour on a sunshiny day. The sugar thus formed was found wherever it went in the plant by pointing a Geiger counter at various parts. Most of the "ticks" that betray the presence of radioactive matter came from the young, growing parts of the cane: root-tips, stem-tip, newest leaf. But there was radiosugar in all parts except a few of the oldest leaves.

Now the Honolulu researchers are making up larger quantities of radiosugar, to be sent to other laboratories for nutritional studies on animals. It will be traced through their bodies just as it was traced through the sugarcane stalk. One sample of radiosugar has already been sent to Dr. Harlan G. Wood of Western Reserve University in Cleveland, Ohio, who will pry its complex molecules apart to see just where the radioactive carbon atoms are built in.

This is only one sample, out of scores of research projects that have been started since radioactive elements were first made available for use in peacetime investigations of biological, medical, agricultural and industrial problems, only one year ago today, and less than two years after the blasting of Hiroshima. More than 1,000 shipments of radioactive elements and compounds have been made thus far.

Another plant research project of both theoretical and practical importance involves the use of radioactive iron. Iron is needed in small quantities by all green plants; it is an indispensable catalyst in the formation of chlorophyll, the green pigment that captures sun-energy and uses it in

making sugar. Phosphorus, another element essential to plant life, under certain conditions "acts cussed," and blocks the iron from entry through the roots. Then the plant becomes pale and anemic-looking—chlorotic, in the plant physiologist's jargon. Chlorosis is more than a laboratory term: fruit trees suffering from it cost American orchardists millions of dollars every year in lost yields. So Dr. Orlin Biddulph of the State College of Washington is working on this phosphorus-iron antagonism with tracer atoms of radioactive iron.

### From Soil to Milk

► AT THE UNIVERSITY of Florida, a radiotracer research task begins with the soil in a cow pasture and winds up in baby's bottle. Radioactive elements, especially cobalt and copper, necessary though only in minimal amounts, are introduced into the soil. Thence they are traced into the grass and legumes that grow from the soil, into the cow that eats the plants, through her into her milk and thus to the ultimate consumer.

These three examples of radiobiological research are only random samples taken from scores of similar projects being carried on in dozens of laboratories and field stations. Among other radioactive elements from the atomic pile here that are being used in these researches are sulfur, iodine, calcium, potassium, sodium and beryllium.

Industry as well as biology and agriculture is making use of "tagged" atoms. Radioactive iron incorporated into steel is used in studies of frictional wear. Radiocalcium in cement

helps to place more accurately the sealing-off layers of concrete deep in oil wells, that block ruinous water-flows. Radiosulfur is helping metallurgists to understand better what happens to this nuisance element in iron smelting. And so on almost indefinitely.

Peacetime uses of atom-splitting have of necessity lagged behind the development of the atom bomb. But they bid fair to overtake and pass this first destructive use of atomic fission.

### **First "Tagging" of Virus**

► DISEASE-CAUSING viruses have become "it" in an exciting game of radioactive atomic "tag."

What is believed to be the first radioactive "tagging" of a disease-causing virus has been accomplished by Dr. Raymond L. Libby and Caroline R. Madison of the American Cyanamid Company's research laboratories at Stamford, Conn.

Scientists are now hopeful that they have made the first move toward finding out why one child catches polio and another does not, why some get colds and others don't, and how important food plants resist their virus attackers.

This latest advance is the indirect result of atomic bomb research because the radioisotopes used were manufactured in one of the giant atom smashers used in the successful attacks on the atom.

Thousands of Chinese farmers produce hand-made paper in off seasons for their own uses; some of it, treated with tung oil, is used for window panes instead of glass.

Cellulose is Sweden's leading export article in normal times; iron ore holds second place and lumber third.

The virus used in the Stamford experiments was that of tobacco mosaic. It is one of the best known of the puzzling proteins that are not alive yet act in many respects like living parasitic organisms. It was given its radioactive "tag" by innoculating it into tobacco seedlings which were then fed with radioactive phosphorus as part of their mineral nutrient solution. The virus acquired its radioactivity from its host.

After the virus had been "tagged" it was extracted, purified, and injected into the bodies of laboratory mice to study their reaction to it as an alien protein. The response of the animals' systems was two-fold: the formation of an immunity-conferring antibody in their blood serum, and the concentration of the radioactive virus largely in liver and spleen.

Now that the way has been shown, other workers will be able to "tag" this and other viruses, and use them in various researches. Of great importance would be the study of mode of entry into, and route of migration within, the body of a number of virus diseases of man and animals, ranging all the way from the common cold to infantile paralysis. Another study might be on the structure of the relatively huge and highly complex virus molecules themselves, and especially on how they "feed" on their hosts' body compounds.

**Physicists Teach Engineers  
Tricks of Nuclear Energy**

## **Atomic Power Engineering**

by ALFRED O. NIER

*Professor of Physics, University of Minnesota  
Consultant, The Kellogg Corporation, New York*

*Address presented before the semi-annual meeting of the American Society of Mechanical Engineers at Chicago, June 1947.*

➤ BEFORE ANY GREAT scientific discovery can be put to every day use, there are formidable engineering problems which must be overcome. Although the fundamental principle of the electric generator was discovered in 1831, over half a century passed before electricity found wide-spread use. New and better ways had to be found for making and insulating copper wire. Magnetic materials had to be studied and special steels developed to make practical the present highly efficient generator and motor. The electric light bulb had to be invented and perfected. The steam turbine had to be developed. These and countless other problems had to be solved by engineers and scientists working together in order to bring the electrical industry to where it is today.

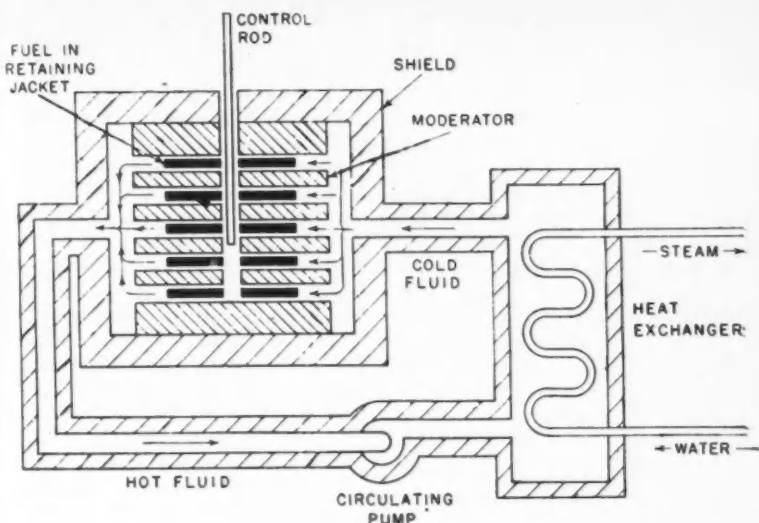
Before atomic energy can be used for practical power production, there are many bridges which must yet be crossed. Because of the complexity of the problems, close cooperation between the scientist and engineer will be required in order that each will understand the other's difficulties.

Although the pressure exerted by the steam in a steam engine is pro-

duced by the impact of countless molecules on the retaining walls, power engineers have never had to concern themselves much with the nature of collisions between gas molecules, the velocities of molecules, or other details of molecular phenomena studied in detail by physicists and physical chemists. An empirical knowledge of the gross properties of matter has usually been sufficient.

In the atomic engine, as in the steam engine, billions and billions of atoms are involved in the production of useful amounts of work. However, unlike the steam engine where all the atoms of the working substance are undergoing the same processes, the atomic engine has many different processes taking place within it simultaneously, some of which compete with one another for atoms. Thus to understand the performance of an atomic engine we must have a rather detailed knowledge of the behavior of individual atoms.

I should like to tell you this evening a little about the behavior of atoms in atomic energy devices, and in doing so, to use a point of view which may be somewhat strange to the engineer but which, I hope, will point out some of the nuclear problems.



*Fig. 1.*

Let us consider first of all the essential parts of an atomic energy engine of the general sort that has been proposed. In Figure 1 is shown a schematic drawing of such an engine. We see here the pieces of uranium or other fissionable substance surrounded by suitable retaining jackets. In addition to the fissionable substance there must be a moderator, a substance which will slow down the fast neutrons produced in the fission process so that they will be useful in producing more fissions. In operation a neutron strikes a uranium 235 nucleus, blows it apart into two heavy fragments, each having about half the mass of the original atom; loose neutrons are also produced in the process. If the device is properly construc-

ted, many of the neutrons produced will in turn strike other uranium atoms, blow them apart, and produce more neutrons and more energetic atom fragments. In other words, if conditions are properly arranged, we will have a chain reaction; the device will itself furnish the neutrons needed to keep the reaction going and in the process act as a source of energy through the conversion of stored atomic energy into kinetic energy of the fragments formed in the fission process. The kinetic energy is converted into heat which may be removed for utilization by circulating a suitable fluid around the slugs of fissionable material. By means of a heat exchanger, steam can then be produced for operation of conventional power.

units. The particular arrangement I have shown is perhaps already obsolete. However, it contains so many of the basic principles involved that it is well worth examining further so that we may gain greater insight into the problem with which we are faced.

Let us see what some of the requirements of our materials of construction are. First of all, we note that the cans housing the fissionable materials must not absorb too many neutrons. The same may be said of the cooling fluid and the moderator. On the other hand, the rods for controlling the neutron density should be good absorbers as should the shield surrounding the reactor and heat exchanger. The fuel itself must not absorb too many neutrons in non-profitable processes and must contain sufficient active material so that as the fission products build up and cause a parasitic loss of neutrons there will be a sufficient excess production to make up for this loss.

Thus we see that the atomic power engineer must not only concern himself with the ordinary properties of his building materials such as thermal conductivity and expansion, entropy, resistance to corrosion and many others, but he must also be concerned with the nuclear properties of the materials. Is there any convenient way in which the nuclear properties may be expressed? Yes, there is, if we note that all the effects in an atomic energy generation system are caused by the collisions of particles or rays with materials. This suggests that we describe the nuclear properties in terms of collision probabilities or in terms of a quantity which we call the cross-section of an atom. These are terms

which are perhaps new to the engineer, but well known to the physicist.

If you are out duck hunting and a flock of birds passes over your head, your chance of hitting one will depend directly upon the size of a bird or more accurately, upon the cross-sectional area which a bird has when viewed from your position. Your chance of bringing down a mallard would be much better than hitting a canary and if ducks were as large as elephants, your chance of hitting one would be materially improved. Moreover, if you could employ basketballs rather than buck shot, you would stand a still better chance of making hits. In other words, the chance of a collision between a shot and a duck is proportional to the size of the duck and of the projectile used; and so it is with atomic nuclei.

If we send a beam of atomic particles against a block of material, some will make collisions with the atoms in the block, others will pass through as shown in Figure 2. Here we show 16 particles striking the front of the block. In the first element of thickness one-half or eight have made collisions, the remainder passing on into the next element where one-half or four of these make collisions leaving two to pass into the next element with only one emerging from the block without having suffered a collision. Had the cross sections of the circles (atoms) been larger, none would have passed through the slab without collision; had the cross sections been smaller, more would have emerged without collision. The cross section is thus a measure of the likelihood of a collision taking place. A large cross



section corresponding to a high probability and vice versa.

Now the term "cross section" is useful in describing a whole host of phenomena. For example, we state that Uranium 235 has a certain fission cross section. By this we refer, of course, to the probability that when a beam of neutrons is sent through a thin slab of material, that a collision will be made which results in fission. Or, we may refer to the elastic collision cross section of an atom in which we refer to the probability of collision taking place without any loss of energy as in the case of the collision of two perfect billiard balls. These are but two examples of the kinds of cross sections atomic physicists talk about. As we shall see, there are others which are useful to define.

Of what order of magnitude are atomic cross sections? In most cases atomic nuclei behave as if they had diameters of about  $10^{-12}$  cm or cross sectional areas of  $10^{-24}$  cm<sup>2</sup>. This number varies greatly from element to element and from process to process and for that matter with the speed and nature of the projectiles employed. Thus a statement of the value of the cross section has no meaning unless the exact process involved is also defined. Cross sections greater than  $10^{-24}$  cm<sup>2</sup> are generally considered large. Thus we see some workers measuring cross sections in terms of "barns," the barn representing an area of  $10^{-24}$  cm<sup>2</sup>, and the implication being that anything is large or larger than this is "big as a barn."

What are some of the atomic cross sections with which we should concern ourselves in atomic power units?

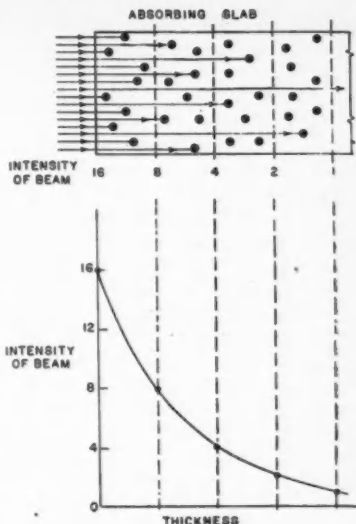


Fig. 2.

First of all, we should be interested in the fission cross section of our fissionable material. In what follows I will assume that we are using U-235. However, similar arguments will apply to other fissionable substances such as Plutonium 239 and Uranium 233. When a U-235 nucleus undergoes fission, the neutrons released have a rather high energy. The fission cross section of U-235 is relatively small for high energy neutrons, but large for really slow neutrons in the thermal energy range. Thus if we wish to produce a chain reaction it is to our advantage to slow down the neutrons. Neutrons may be slowed down by making elastic collisions with atomic nuclei. Thus our reactor should contain some substances with which the neutrons may collide. However, in

making the collisions we must make sure that the neutrons are not lost in some absorption process. In other words, our slowing down medium, technically called the "moderator," should have a high cross section for elastic collisions and a low cross section for capturing neutrons. In any event, we should try to slow down the neutrons in as few collisions as possible since then there will be a minimum of chance of losing neutrons. By the ordinary laws of mechanics, we can show that if we slow down an object, by letting it make an elastic collision with some stationary object, we lose the greatest amount of energy in a collision if the masses of the two objects are equal, in which case, we will lose 50 per cent of the energy per collision. This suggests immediately that we should employ hydrogen as a moderator since the mass of the hydrogen atom is the same as that of the neutron. Thus if we wished to slow down a million electron volt neutron to an energy of 0.1 electron volt, about 20 collisions would be required, (the electron volt is a unit of energy and represents the amount of energy acquired by an electron which falls through a difference of potential of 1 volt). On the other hand, if we chose to lose this energy by allowing collisions with, let us say, carbon atoms which are twelve times

as heavy as neutrons, we would lose only 14 per cent of the energy in a collision and we would need 123, or six times as many collisions. However, this is not the entire story for we must also consider the fact that there is a certain probability of absorption of neutrons in our slowing down material. As a matter of fact there are a number of elements for which the absorption cross section is much less than for hydrogen and hence are better moderators in spite of their greater mass. In an article which appeared in the February, 1947 issue of *Instruments*, Dr. E. C. Creutz summarizes this matter very well in a table which I will show as Figure 3. The first column shows the fraction of energy lost by a neutron each time it makes an elastic collision with a nucleus of one of the elements listed. In the the second column is shown a rough value for the scattering cross section. The product  $f\sigma_s$  is thus a measure of the ease of slowing down a neutron by means of elastic collisions. In column four are shown rough values for the absorption cross section. The larger this quantity is the greater will be the chance of losing a neutron by absorption. Thus the ratio  $f\sigma_s/\sigma_a$  can be considered as a figure of merit of the element as a slowing down medium. We see, for example, that helium would be an excellent

	$f$	$\sigma_s$	$f\sigma_s$	$\sigma_a$	$f\sigma_s/\sigma_a$
Hydrogen	0.5	20	10	0.3	30
Helium	0.3	1.5	0.48	0	large
Lithium	0.25	6	1.5	60	0.02
Beryllium	0.22	6	1.3	0.007	185
Boron	0.16	6	.96	700	0.001
Carbon	0.14	5	.7	0.004	175

Fig. 3.

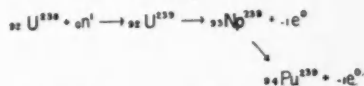
material to use, but since it is a gas, it would be hard to obtain a high density of atoms without the use of very high pressures. Ordinary hydrogen is not especially good. Heavy hydrogen, not listed, is much better. Lithium and boron, because they absorb neutrons so readily, are very poor substances to use as slowing-down media. On the other hand, beryllium and carbon are very good. Because of the availability of the latter in the form of graphite it was actually used in the chain reacting piles now operating.

Figure 3 is useful in other ways. It shows the need for extremely pure materials of construction. For example, if carbon is used as a moderator, and if it contains only ten parts per million of boron as an impurity as many neutrons will be absorbed by the boron as by the carbon itself.

The competition between profitable and non-profitable utilization of neutrons is one which we must contend with throughout this problem. For example, when ordinary uranium is used as a fuel in a reactor we have 139 times as many U-238 as U-235 atoms present. Now if we plot the absorption cross section of U-238 as a function of neutron energy we find that it has a sharp maximum, or resonance, value at a neutron energy intermediate between that of the neutrons produced and the energy required for maximum fission of U-235. Thus, in slowing down the neutrons, we stand a good chance in losing a large share of them as they pass through the resonance region. Fortunately, the effect may be minimized by proper geometrical arrangement of the uranium relative to the

moderator. In the future, the utilization of uranium in which the U-235 has been enriched will further reduce the importance of this factor.

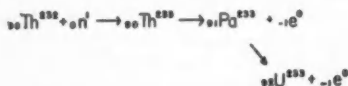
We have just mentioned that the resonance absorption by U-238 diverted neutrons from accomplishing our main objective, the fission of U-235. However, when we consider what happens as a result of the absorption process we see that this is not a total loss. We find that when a neutron is captured by U-238 the following nuclear reactions take place.



First of all a new atom of uranium, U-239, is formed which is unstable and decays to form Neptunium-239; an electron  ${}_{-1}^0\text{e}^0$  is discarded in the process. The Neptunium-239 is also unstable and decays to form Plutonium-239. In this equation the superscripts refer to the atomic mass of the atom or particle and the subscripts to the atomic number. It turns out that Pu-239 like U-235 has the remarkable property that when struck by neutrons of the proper energy it, too, will undergo fission. Thus while we are losing U-235 we are gaining Pu-239. Since only 1/140 of the uranium atoms in nature are U-235 we see the economic consequence of the plutonium creation. If things could be arranged that for each U-235 atom lost one or more Pu-239 atom was created, we could soon dispense with the utilization of U-235 and would instead "burn up" the 139 times more abundant U-238 instead of the rare and precious U-235. Even if this goal is never achieved, the production of

some Pu-239 will reduce the demand for U-235.

The same argument holds for the production of U-233 from thorium. In this case our nuclear reactions are:



If any neutrons over and above the minimum required to keep the chain going, could be diverted into making U-233 we would again lessen our drain on the U-235 stock and replace it by a drain on the much more abundant element thorium. These statements are pure conjectures. The practicality of the usefulness of these processes remains among the interesting problems of the future.

When an atomic fuel undergoes fission, elements near the middle of the atomic table are formed. For each atom of U-235 which is destroyed two new lighter atoms are created. Some of these will have a low cross section for absorption of neutrons. Others will have larger values and will act as parasites in removing neutrons from the pile. Thus in any practical atomic "furnace" the waste products must be removed. In the Hanford Plant the problem was solved by removing the canned uranium slugs at regular intervals, dissolving the contents by a laborious chemical process, and separating out the uranium and plutonium for further work. This might be fairly a straight forward operation were it not for the fact that the fission products are so strongly radioactive that all chemical manipulation had to be done in batch processes by remote control behind thick concrete shields.

The replacement of the batch handling by continuous methods should be a challenging problem to the engineer and would do much to lower the cost of atomic energy.

We have already mentioned that different elements interact in different ways with neutrons. Consider for example the element cadmium. This element has long been known to be one of the best absorbers of slow neutrons which we have. Cadmium is known to consist of eight different kinds of atoms ranging in mass from 106 to 116 times the mass of hydrogen. Recently it was shown that the abnormally high neutron absorption cross section could be attributed entirely to one type of cadmium atom, the isotope of mass 113, which has an abundance of only twelve per cent. In spite of the fact that cadmium is a very good neutron absorber, we would have one of eight times the absorbing power if this particular isotope could be isolated in quantity.

I mention this fact, not because cadmium is of more or even as much interest in atomic energy work as are other elements, but because it shows so strikingly how some atoms of an element have quite different nuclear properties than others. The nuclear properties which we ordinarily observe for an element are in reality the weighted average properties of the several isotopes which make up the element. Perhaps we shall some time see the day when separated isotopes of any element will be available at reasonable cost. If this ever happens, it will mean having additional building materials for atomic reactors at our disposal because we may then utilize elements not now acceptable

because one or more of their isotopes may have objectionable properties. At the present time the separation of isotopes is so difficult and expensive that only in the case of uranium does it pay to carry out the separation.

You have all seen figures showing that if one pound of uranium, an amount about the size of a golf ball, undergoes fission there will be released energy in amount roughly equivalent to 200,000 gallons of gasoline. To the average motorist this would be enough energy to run his car for 200 years. Unfortunately there is a hitch in all this. It has been estimated that in order for it to be safe for a human being to be near an atomic reactor, at least 50 tons of shielding material are required — an amount somewhat more than your car can stand! While this rules out small mobile installations, such a weight of shielding would not be particularly detrimental in stationary units or large propulsion units such as might be used on ships.

Why must such heavy shield be employed? To answer this we must inquire what it is we are shielding against. First of all, there are the neutrons, the particles which make the chain reaction possible. We have already indicated that for efficient operation of the reactor as many as possible of the neutrons should be utilized in producing more fissions. This suggests that, first of all, the pile be surrounded by an envelope of an element which has the property of readily reflecting neutrons without absorbing them. While such an envelope will help reflect a fair proportion of the neutrons which would ordinarily escape back into the pile, it still would

permit a large number to leave. Thus to protect personnel, additional neutron absorbing material is required.

Many of the fission fragments formed are highly unstable and decay to form more stable atoms. In the process gamma rays are emitted. These, like x-rays, are electromagnetic in character but because of the higher energy are more penetrating. Like x-rays, they are absorbed most readily by the heavy elements. In practice concrete has been used as an absorber for both the neutrons and the gamma rays.

In this brief discussion I have touched on only a few of the problems associated with the atomic processes taking place. I have not even had opportunity to discuss the very interesting engineering problem of the regulation of the power output of the reactor by means of automatic adjustment of the position of neutron absorbing control rods in the reactor. This is a large topic in itself.

In my talk I have touched on a number of new concepts or terms which form part of the vocabulary of atom workers. I have talked about fission cross sections, absorption cross sections, scattering cross sections, moderators and reflectors. I have not even mentioned such things as radiation stability, homogeneous or heterogeneous reactors, power ratings of reactors, any of the special instrumentation required, or the health problems encountered in connection with atomic reactors. As in any new field new terms do not always mean the same thing to all people. Before any large scale use can be made of atomic energy, we will all have to get together and decide on some nuclear

codes and standards to insure an orderly and safe development of the field. Here, by setting up a committee to consider these matters, the A.S.M.E. can make a real contribution toward advancing the future of atomic energy.

One might summarize what I have discussed this evening by stating that the problem of producing atomic energy is largely one of making efficient use of neutrons. This and the concept of atomic fission are really the only basically new factors with which the

engineer must contend. Otherwise the problem of producing atomic energy involves merely modifications of problems which engineers have already solved or will solve in connection with other work. Thus there are many developments which will go hand in hand with those already being carried on in industry and engineers can make substantial contributions toward making atomic energy an every-day reality by merely extending their scope of operations.

## *On the Back Cover*

► FIVE POINTED STARS, at least two of which appear in this photograph, represent the most complete disintegration of the atomic nucleus ever achieved by man. They were photographed in a cloud chamber during bombardments with 100-million-electron-volt neutrons from the new giant University of California cyclotron.

Similar photographs have been made of occurrences in cosmic radiation. Electrons from the betatron have caused three-pointed stars.

Neutrons of such high energy as those recorded here are in effect low-energy cosmic rays. Because they have

no charge, neutrons are not themselves photographed, but the charged particles emerging from a cracked nucleus are recorded. Each point of the star, or line of those radiating from a single spot, represents such a charged particle.

The photographs were made in a large cloud chamber, 16 inches in diameter, which was placed in a strong magnetic field of 10,000 gauss. The research was done by Dr. Wilson Powell, associate professor of physics, and was sponsored by the Atomic Energy Commission.

## *Streptomycin "Disciplines" Molds*

► MOLDS grown in mass cultures for the production of streptomycin often undergo rapid evolutionary processes that result in the growth of strains of low productive capacity. It has been discovered that this tendency of cultures to "run down" can be checked

by adding a little pure streptomycin to the nutrient liquid. This work was done by Drs. C. J. Christensen, F. J. Rudert and Milton J. Foter of the William S. Merell Company of Cincinnati.

**London is Scene of Eleventh International  
Congress of Pure and Applied Chemistry**

## **World Congress of Chemistry**

► **THE FIRST** gathering of chemists of the world since the war, was held in London in July, and many of the delegates gathered early to join their British colleagues in celebrating the centenary of the Chemical Society (of London) which was founded in 1841.

Both the Eleventh International Congress of Pure and Applied Chemistry and the Chemical Society centenary were scheduled for 1941 but the war caused a postponement.

A large delegation of American chemists, including the principal officers of the American Chemical Society, were in attendance.

Since the last meeting of the congress in Rome in 1938 the most spectacular chemical advances have been in the field of atomic energy, but the 1947 congress was held with very little recognition of this important expansion of chemical field. Papers relating directly to atomic energy were not on the program, since this seems to be a subject not yet capable of international discussion.

Through its London correspondent, CHEMISTRY has gathered the important highlights of the congress.

### **Interatomic Forces in Metals**

► **EVIDENCE** gained from spectrum lines, which are direct messages from the heart of the atom, is used to interpret mysterious forces and ordinary properties of metals in the address by Dr. Linus Pauling of the California Institute of Technology, who

was president of Section 2 of the congress.

The classical theory of atom structure supposes the nucleus, the sun of the atomic solar system, surrounded by electrons in their orbits. Each shell of atom structure contains a fixed number of orbits, and only when one shell is completed can the next electron take up a position farther from the nucleus and start a new shell.

However, the properties of certain elements have led chemists to the belief that exceptions to this rule occur under certain circumstances, and that forces within the atom sometimes allow electrons to take up positions in outer shells before the inner shells are completely filled.

Dr. Pauling starts with the idea that shells may be only partially filled in the so-called transition elements, occurring in the middle of the long series of metals in the Periodic Table. From calculations based on this assumption, he is able to account for well-known but previously unexplained differences in their properties and behavior.

Dr. Pauling's communication is summarized as follows:

The questions of the nature of the interatomic forces in metals and their relations to mechanical properties, such as strength and hardness, have not yet been given a satisfactory answer. In the quantum-mechanical treatment of this problem it has been generally



assumed that in the transition elements (iron, cobalt, nickel, etc.) the 3d shell is filled with ten electrons, or is nearly filled, and that the d-electrons make no significant contribution to the cohesive forces. Thus copper has been assumed to have a completed 3d shell, and to have one electron that serves as bonding electron, whereas in nickel the 3d shell has been assumed to have a defect of 0.6 electrons per atom, with 0.6 electrons serving to produce the cohesive forces.

An alternative treatment of metals has been developed, based upon the idea that the 4f, 4p, and 3d orbitals of the iron group elements are hybridized and that there are three classes of hybrid orbitals formed. The orbitals of the first class are specially suited to the formation of covalent bonds, those of the second class are stable non-bonding atomic orbitals, and those of the third class are unstable orbitals. Values of the saturation ferromagnetic moment of the transition elements can be interpreted to show that there are 5.78 good bonding orbitals, 2.44 stable atomic orbitals, and 0.78 unstable orbitals. This interpretation provides a qualitative explanation of many properties of the transition metals, such as characteristic temperature, hardness, compressibility, and coefficient of thermal expansion.

Further evidence to support it has been obtained by the analysis of interatomic distances in metals and intermetallic compounds. An equation has been formulated to express the change in covalent radius of an atom with change in bond number, the stabilizing (bond-shortening) effect of the resonance of shared-electron

bonds among alternative positions also being taken into consideration. This equation has been applied to the empirical interatomic-distance data for the elementary metals to obtain a nearly complete set of single-bond radii, tetrahedral radii, and octahedral radii of the elements, in such a way as to provide strong support for the idea that the interatomic forces in metals are for the most part due to covalent bonds resonating among the available interatomic positions.

It is found that chromium atoms, manganese atoms, and tin atoms exist in metals in two forms, a small, high-valent form and a larger low-valent form. The two kinds of manganese atoms co-exist in  $\alpha$ -manganese and in  $\beta$ -manganese. In many metals each atom is attached to some of its neighbours by strong bonds and to others by weaker bonds. Interatomic distances can be interpreted to provide values of the effective valences of atoms in intermetallic compounds, and to help in explaining the complex structures observed.

### **Rust Due to Electric Current**

► **PROOF** THAT the rusting of iron is due to electrochemical currents like those from an ordinary electric battery was reported by the British chemist, Dr. U. R. Evans.

The theory that corrosion of metals is caused by electric currents between different parts of the surface has been held by chemists for more than a century, but few attempts have been made to detect and measure them. Dr. Evans has devised six methods for measuring the amounts of currents flowing over corroding metal, and an instrument to determine the source and direction of such currents.



He has the satisfaction of proving that the long-held theory of metal corrosion is a fact, and of learning that the spots where the metal is eaten away are the anodes, or positive poles, of the local battery action. Places which do not show corrosion are either the cathodes, where metal is being deposited, or neutral zones between the tiny battery systems.

### **Kills Germs Without Suds**

➤ SOAPLESS SOAP that kills germs efficiently in the washing machine and yet doesn't produce excessive suds to prevent cleansing action has been invented. Cleanliness in laundry work is increased by the new chemical attack on the dirty clothes problem, reported to the congress.

Bacteriological cleanliness is now achieved by washing with strongly alkaline chemicals, but they are bad for the clothes. Some of the new ammonium compounds used as detergents are good wetting agents and disinfectants, but build up so much foam that it interferes with the operation of the washing machine.

Drs. J. C. L. Resuggan and J. G. Davis, British chemists, reported to the meeting their solution of the dilemma by remaking the chemical structure of the detergent. Ammonium compounds heretofore used have been formed of long chains of 12 to 18 carbon atoms.

"It has now been found," Drs. Resuggan and Davis state, "that by substituting for the single long chain two shorter chains in a quaternary ammonium compound, ability to form stable foams in all but relatively high concentrations is destroyed, while, when suitable chains are used, the

compound has considerable bactericidal and wetting powers."

The new compounds, with or without addition of a mild alkali instead of the present strong ones, are expected to kill germs better, help get the clothes cleaner, and avoid too much suds. Patents on this type of compounds have been applied for.

### **Plasticizer From Bark**

➤ A WAXLIKE material known for a century to exist in the bark of pine trees promises to become one of the most important substances in the modern making of plastics.

Prof. H. von Euler of Sweden reported to the congress here that this bark product, called phlobaphene, is a new and cheap softening agent or plasticizer.

The chemical nature of these phlobaphene bark substances has been determined by Prof. Van Euler and they are described chemically as catechol-esters of different saturated and non-saturated aliphatic acids, containing 16 to 22 carbon atoms.

Bark is a waste product in lumbering operations and its utilization is a problem. Manufacture of phlobaphenes from the bark will help solve this difficulty and give the plastics industry a new material. The plasticizers from bark are suitable for replacing plasticizers from castor oil and alkyl products, as well as the phthalic acid derivatives, made from coal.

Up to 30% of synthetic resins produced consists of the plasticizers. The volume of the bark materials needed will be large.

### **Five Year Plastics Expansion**

➤ THE UNITED STATES plastics industry will continue its phenomenal growth for at least another five years,

Dr. N. N. T. Samaras, director of research for Monsanto Chemical Company's Plastics Division at Springfield, Mass., told the congress.

This growth will be aided by technological developments and, as he put it, by a youthful aggressiveness and versatility which cannot be denied."

At least 50 million dollars has been spent in the United States on synthetic resin research since 1939, Dr. Samaras reported, and the number of technically trained specialists engaged in this field has probably trebled in the last eight years.

This research emphasis will have a continuing effect on the industry whose future growth, according to Dr. Samaras, is based on development of blends of plastics, mechanical alteration of existing materials, innovations in mass production techniques, greater supplies of basic raw materials, and pioneering of plastics research in the field of carbon, silicon, sulfur, phosphorus and nitrogen types.

In 1939 the United States achieved world plastics leadership, producing 250 million pounds of intermediates valued at \$50,000,000. The real growth occurred during the next seven years, however, when production was increased 500%. This expansion, he pointed out, was exceeded only by that of synthetic rubber and magnesium.

A dozen plastics materials grew from pilot plant experimentation to large scale production. Polyvinyls, of negligible volume in 1939, were exceeded in tonnage in 1946 only by alkyds and phenolics, and on a dollar basis were virtually equal. Polystyrene, spurred when the monomer became

available via the synthetic rubber program, ranked sixth by 1946 and may be second by 1949. Nine new polymers arrived on the commercial scene — silicones, polytetrafluoroethylene, and melamines being among the most notable chemically. Innumerable new end-uses have appeared. Paper and textile treatment, adhesives, wire-coating and other miscellaneous applications today consume greater tonnage than moulding.

Development of fabrication machinery, coupled with the raw materials manufacturer's progress in learning the use of continuous processes instead of "batch" methods, aided materially. Together with these factors were the developments of new materials and improvements in existing ones which were made by research men and the development work in the field of combining plastics with wood, glass, paper, cloth and metal.

"The belief that the great volume of plastics materials is consumed in molding applications is a popular fallacy," he said, pointing out that "it is readily apparent from a study of the industry that molding and casting together constitute less than 30 per cent of the total plastics materials output. This tendency of plastics to find increasing applications in new fields by combining with older materials is most significant and augurs well for the future of the industry."

Economic factors that have influenced the industry's growth, were listed as follows:

1. Steadily declining prices have naturally stimulated wider interest and application.
2. The United States is very fortunate in having a relatively abund-

ant and varied source of raw materials.

3. The industry has benefited from sustained confidence in its ability to make money. Indicative of this faith is the fact that the plastics producers in the United States intend to spend an estimated \$150,000,000, for expansion of production facilities in the 1946-1948 period.

### **New Penicillins Being Built**

➤ NEW CHEMICAL drugs that may be better than the wonder germ-killer, penicillin, are being built in the laboratory, the International Chemical Congress here was told by several teams of chemists.

Intermediate compounds that lead toward new forms of penicillin have been prepared, Dr. A. H. Cook reported for a group working under Sir Ian Heilbron of London's Imperial College of Science.

Many steps toward making artificial streptomycin, the other wonder mold chemical, have been taken, Dr. Karl Folkers of Merck Laboratories in New Jersey, told the congress. The synthesis of this drug will be more difficult than that of penicillin, he admitted.

### **Strychnine Related to Quinine**

➤ THE PUZZLE of how strychnine, powerful poison, is put together chemically is being worked upon by Sir Robert Robinson, president of the famous Royal Society and Oxford chemist.

So complex is the task that Sir Robert during the chemical congress called this drug "a kind of monkey puzzle to organic chemists."

The strychnine molecule contains seven atomic rings interlocked in an uncertain manner. Sir Robert's dis-

coveries have shown a close relationship to quinine in part of strychnine's molecular skeleton.

Unfortunately there is no prospect, in his opinion, of making quinine from strychnine because the natural molecules are molded in different ways.

### **Francium Becomes Astatine**

➤ A NEW TWIN of one of the most recently discovered chemical elements turns into another rare element after existing only five minutes.

Prof. F. A. Paneth of Durham University called the attention of the congress to this new isotope of element 87. This fundamental chemical building block was christened francium only this year by Mlle. Marguerite Perey of the Paris Radium Institute, who first discovered a radioactive isotope of element 87 with a half-life of 21 minutes.

The new isotope of 87 with a half period of 5 minutes emits alpha particles and changes into the element astatine number 85.

The discovery of the new 5 minute francium isotope will be reported in a scientific paper by Drs. A. C. English, T. E. Crawford and their collaborators to be sent to the Physical Review, U. S. scientific journal.

### **Cows Eat Wood Pulp**

➤ COWS AND newspaper presses are rivals for the same kind of raw material — cellulose from spruce wood.

The International Chemical Congress was told that cattle can be fed upon sulfite pulp of exactly the same sort that newsprint paper is made from.

This will be unhappy news for newspaper editors throughout the world who are acutely aware of the

shortage of newsprint paper and pulp.

During the war in Norway three-quarters of a million tons of cellulose were used as cattle fodder, following experiments that demonstrated under what conditions animals could eat it and benefit from it.

Drs. H. Hvidsten and T. Homb of the Norwegian Agricultural School at Vallebeck reported to the chemists that the cellulose must be supplemented by protein material in order that its carbohydrate content may be properly utilized by the animals. For pigs, however, the cellulose was reported to have no feeding value.

The cellulose is bleachable sulfite cellulose from spruce wood with a lignin content of 1% to 2%.

Chopped straw processed with a 1.2% to 1.5% sodium hydroxide solution was also found to have value as an animal feed.

#### **Acids Present in Silage**

► IN BOTH Switzerland and Denmark acids were extensively used during the war to preserve for winter animal feeding green grass and other silage crops. One method consists of spraying a 5% solution of formic acid over the green stuff in the silo. A cheaper way is to use a combined solution of hydrochloric and sulfuric acids, a method originated by Dr. A. I. Virtanen and called by his initials, the AIV method.

Dr. O. Heinzl of Zurich told the chemists that 20 years of experience in Switzerland have shown that the acids do not prevent animals from thriving on this feed.

#### **Acetic Acid Protects Milk**

► ACETIC ACID, most familiar in vinegar, can be used as a temporary preservative of skim milk that will be

fed to calves, Dr. V. Steensberg of Copenhagen told the congress. The calves like better milk artificially soured by lactic acid, however.

#### **Chemical Constitution of Coal**

► THE CHEMICAL constitution of coal has been explored by Professor H. L. Riley, director of research of the British National Coal Board, by the application of X-ray analysis. When powdered coal is subjected to X-ray diffraction, the resulting pattern does not look at all promising—only two broad and diffuse bands. Nevertheless, by dint of a large number of tests, and by the careful exploration of the photographic plates with a microphotometer, quite a lot has been discovered.

The main band can be resolved, in the case of many coals, into a main and a subsidiary band, and the presence of the latter seems to be correlated with the coking property of the coal. The band can be removed by heating to carbonisation temperature, or by dissolving out what is usually known as the gamma-fraction by organic solvents. Another method of approach is to plot the half-width of the diffraction band and to trace the variation of this dimension with temperature for a number of different kinds of coal. By this procedure characteristic curves are obtained for the various coals, and the coking property can again be correlated with a particular hump in the curve.

The general conclusion drawn from these and other experiments is that the coking property is associated with a flat molecular pattern, and that the disc-like units jostle one another into a sort of uni-dimensional semi-crystalline form. A model of this system can

be made with celluloid discs the size of a penny shaken together in a tray. First there is purely random piling, then an approximate pattern is produced merely by gentle shaking. Some sample "cokes" were made from organic chemicals. These are "probably the most expensive cokes ever made," Prof. Riley commented. Cokes made from flat molecules such as dibenzanthrone showed very similar properties to ordinary coke in these tests.

From British Fuel Research Station, Dr. L. Horton and Dr. R. B. Randall discussed the nature of the combination of sulphur and nitrogen in coal. In spite of the great importance of the subject, very little work has been done on it, and Dr. Horton was prepared to say that on the question of the sulphur "we know absolutely nothing," while as to the nitrogen "we know practically nothing." He was prepared to go further and say that his own work had in no way improved the situation, but in fact his experiments have already led to some very tentative conclusions, and the research team at Greenwich is following these up. The very careful laboratory work done on bright coal from Yorkshire shows that about half of the sulphur is relatively easily converted to soluble sulphates by oxidising agents, whereas the nitrogen is much more resistant. The situation would be consistent with nitrogen being contained largely in heterocyclic rings and the sulphur largely in bridge-chains, but it is much too early to be able to put this forward as a definite assertion.

From Liège University, Prof. A. Gillet put forward his views on the

composition of coal based largely on a reaction of powdered coal dissolved in anthracene at 350° with oleic acid. This, he claimed, resulted in over 90% of the coal reacting to form a chemical compound in which units having the empirical composition of  $C_{29}H_{22}O_{2.8}$  combined with one molecule of the oleic acid. This claim was received with a certain amount of scepticism, Dr. H. H. Lowry, United States, and others expressing the belief that coal was a mixture of similar compounds rather than a pure chemical. Prof. Gillet stated that he had held that viewpoint formerly, but had been forced to abandon it by the weight of experimental evidence.

### How Body is Nourished

► TRACEABLE ISOTOPES of elements normally present in the tissues have shed a great deal of new light on the mechanism of exchange by which the body is nourished. Labelled atoms of sodium, phosphorus and iron were followed in researches reported to the congress by Dr. G. von Hevesy of Sweden. Their progress from blood plasma to the red corpuscles and their exchange from corpuscles into bone marrow was charted. The lifetime of individual corpuscles was measured both in the case of the domestic hen (30 days) and of human beings (four times as long).

Details of these experiments, as reported by Dr. von Hevesy, are:

A change in the concentration of chloride, carbonate, phosphate and several other anions in the blood plasma is soon followed by a corresponding change in the concentration of these ions in the red corpuscles. But even if the concentration remains con-

stant a large part of the ions present at any time in the plasma will soon be found in the corpuscles, and vice versa. This can be shown by labelling the ions present in the plasma by addition of an isotopic indicator of negligible weight. When radioactive sodium phosphate ( $\text{Na}_2\text{H}^{32}\text{PO}_4$ ) is added, for example, to human blood kept at  $37^\circ$ , after the lapse of 2 hours about  $\frac{1}{2}$  of the  $^{32}\text{P}$  atoms is found in the red corpuscles, indicating a fairly rapid penetration of the phosphate ions through the corpuscle membrane. In spite of this fact and that the inorganic phosphorus content of 1 g corpuscles is appreciably lower than that of 1 g plasma, the ratio of inorganic  $^{32}\text{P}$ : $^{31}\text{P}$  is found after 2 hours to be much lower in the corpuscles than in the plasma. This result is due to a very rapid renewal of many of the organic acid-soluble compounds present in the corpuscles. In the course of phosphorylating processes incessantly going on in the corpuscles such acid-soluble molecules split off their phosphate content while others get phosphorylated under participation of labelled inorganic phosphate. This process leads in experiments of restricted duration to a replacement of much of the inorganic  $^{32}\text{P}$  of the corpuscles by  $^{31}\text{P}$  previously located in the organic molecules. It is due to this fact that while from 100 atoms  $^{32}\text{P}$  added to the plasma in the course of 2 hours 50 pass into the corpuscles, from 100  $^{32}\text{P}$  atoms present in the corpuscles only 2 move in the opposite direction.

The facts described make possible the application of "phosphorus labelled" red corpuscles in the study of

the circulation of the red corpuscles and in the determination of the amount of circulating red corpuscles in the total body or in a single organ. Such determinations can also be carried out by "iron labelled" corpuscles. Radioiron introduced into the organism is incorporated into the corpuscles during their formation in the bone marrow. "Iron labelled" corpuscles represent thus a very different type of tagged erythrocytes. They have the advantage of keeping their label all through their life-time of the corpuscle but have the disadvantage that their application necessitates a blood donor. "Phosphorus labelled" red corpuscles can be produced in vitro and a patient's blood can be reinjected after having kept it for a while after addition of radioactive phosphate at  $37^\circ$ . Neither the "phosphorus labelled" nor the "iron labelled" corpuscles can be used in the determination of the life cycle of the red corpuscle. Radioiron given off by hemolysing corpuscles is to a large extent utilized to a formation of new corpuscles, while the "phosphorus labelled" corpuscles lose partly their label during the life time of the erythrocytes. The life-cycle of the nucleated red corpuscles of the hen was however determined by making use of the fact that the desoxyribose nucleic acid molecules present in these corpuscles remains unchanged through the life-time of the corpuscles. All red corpuscles of the hen were found to have about the same life-time of 30 days. The life-cycle of human red corpuscles was determined by feeding glycine labelled with  $^{15}\text{N}$  which results in the formation of labelled heme. As the  $^{15}\text{N}$  of

the heme does not interchange through the life-time of the corpuscle nor is it reutilized for hemoglobin formation the time of disappearance of  $^{15}\text{N}$  of the heme indicates the life-time of the red corpuscles, which was found to be 4 months.

A change in the potassium concentration of the plasma does not lead to a corresponding change in the potassium concentration of the corpuscles. This result is due to the restricted capacity of the corpuscles to accumulate potassium, which is only to a minor extent influenced by an increase in the potassium concentration of the plasma. A capacity which is intimately connected with metabolic processes going on in the corpuscles.  $^{42}\text{K}$   $^{24}\text{Na}$  added to the plasma is soon found to be present in appreciable amounts in the corpuscles, a corresponding amount of  $^{39}\text{K}$ ,  $^{41}\text{K}$  resp,  $^{23}\text{Na}$  moving in the opposite direction, demonstrating the marked permeability of the red corpuscles to these ions.

### **Tin Coats on Steel**

► A NEW USE for tin coatings on steel is as an undercoat for paint, Dr. Ernest S. Hedges, British chemist told the congress. For this purpose very thin tin coatings (0.00005in.) suffice and the combination tin plus paint is far more protective than would be expected from the protection afforded by tin or paint alone.

The main applications of tin mark it out as a metal used largely for its chemical properties, particularly as a coating on other metals. Its mechanical weakness renders it unfit for con-

structional uses, except where its weakness can be exploited, as in foil and collapsible tubes, but its non-toxicity and relative freedom from corrosion by weak acids, alkalis and other electrolytes have given tin coatings a sure field of usefulness in the food industries and similar applications. Tin coatings are usually applied either by hot-dipping in molten tin or by electrodeposition.

New methods involving the use of molten salts instead of aqueous pickling and fluxing liquors are particularly advantageous in hot-tinning cast iron, where troubles caused by surface graphite are aggravated by acid pickling.

Much progress has been made in recent years in the electrodeposition of tin, particularly in the continuous deposition of thin coatings of tin on wide strip at high speed in the modern manufacture of electrotinplate. A recent innovation is the co-deposition of tin-zinc alloys, which are shown to form remarkably protective coatings on steel, particularly where resistance to chloride solutions is concerned. The corrosion resistance of both tin and tin-zinc alloy coatings on steel can be enhanced by passivation treatments.

### **Next U.S.A. in 1951**

► THE TWELFTH International Congress of Pure and Applied Chemistry will be held in the United States in 1951.

Dr. W. Albert Noyes, Jr., president of the American Chemical Society, said the 1951 meeting would probably be held in New York City.

**Floral oils for American perfumery are produced in large quantities in southern France in normal times.**



## For the Home Lab

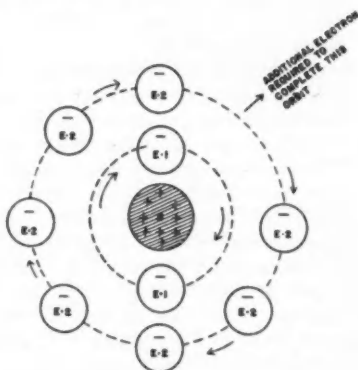
# The Hot-Headed Halogens - IV

### Fluorine

by BURTON L. HAWK

► THE ISOLATION of fluorine, the most active of all elements, required many long years of dangerous and painstaking research. Davy, Gay-Lussac, Thenard, the Knox brothers, Fremy and Gore were among the many noted chemists who tried unsuccessfully to free fluorine from its compounds. Louyet and Nickles both succumbed to the poisonous vapors of hydrogen fluoride and thus died martyrs to science in their efforts to obtain the elusive fluorine. The long search finally ended when Moissan liberated the element in 1886, after many unsuccessful attempts and much suffering from inhaling hydrofluoric acid vapors. His method consisted of the electrolysis of dry potassium bifluoride dissolved in anhydrous hydrofluoric acid cooled to a temperature of  $-23^{\circ}$ . He used platinum-iridium electrodes in a platinum U-tube covered with fluospar caps. (For a more detailed report on the history and properties of the fascinating element, read "Fluorine the Furious" . . . CHEMISTRY, October 1946.)

Assuming that the average home lab is not equipped with the elaborate apparatus necessary for the preparation of fluorine, we must confine our interests to the properties of the compounds of fluorine. All fluorides are poisonous and therefore must be handled carefully. Hydrofluoric acid is extremely caustic causing painful sores if spilled on the skin; its vapor is irritating and must not be inhaled.



THE FLUORINE ATOM

► THE REMARKABLE ACTIVITY of fluorine may be explained by visualizing the atom as outlined above. Electrons tend to revolve in orbits or groups around the nucleus which is assumed to contain the protons and neutrons. The first group is complete with two electrons (E-1); the second group is complete with eight electrons (E-2). Now atoms tend to react in such a way as to form a complete orbit of electrons. You will note that fluorine has but seven electrons in its outer group and thus is extremely anxious to acquire one more to complete the orbit group. Hence whenever fluorine is set free, it immediately grabs an electron from the nearest available element.

The element neon, on the other hand, already has eight electrons in its outer group; therefore, it is completely satisfied and chemically inert.



## Etching Glass

Although hydrofluoric acid is a relatively weak acid and reacts slowly upon metals, it is unique in that it reacts readily with silica and silicates:

$\text{CaSiO}_3 + 6\text{HF} \rightarrow \text{SiF}_4 + \text{CaF}_2 + 3\text{H}_2\text{O}$   
Hence it attacks glass, porcelain, clay-ware, etc. This property is utilized in the etching and frosting of glass articles.

Cover the article to be etched with a thin coating of wax. The design or lettering is then made by cutting through the wax with a sharp instrument. The hydrofluoric acid vapors will attack that portion of the glass exposed producing a rough surface. Burettes and other glass ware are graduated in this manner.

To prepare the hydrofluoric acid, mix 1 gram of calcium fluoride with enough sulfuric acid to form a thin paste. The mixture must be placed in a lead dish. Or if you have a few platinum or iridium dishes, they may be used instead. Now place the wax-coated glass over the dish and allow to stand overnight. The action can be hastened by gently warming the dish, but care must be taken not to melt the wax and thus spoil the design. After sufficient exposure to the acid vapors, the wax is removed by melting, leaving the etched outline of the design on the glass.

## Fluosilicates

When con. sulfuric acid is added to a small quantity of a mixture of silica and calcium fluoride, silicon tetrafluoride, a gas, is given off. This gas dissolves readily in water forming silicic acid and fluosilicic acid. The former can be removed by precipitation leaving the latter in solution:

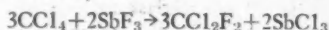


Potassium fluosilicate (or silicofluoride) is one of the few salts of this metal which is insoluble in water. For this reason, fluosilicic acid is used in analysis. If potassium chloride solution be added to the fluosilicic acid, a translucent and gelatinous precipitate is formed which will be increased by the addition of alcohol.

## Organic Fluoro Compounds

Recently many new fluoro compounds have been prepared with the possibilities of many more yet to be investigated.

One of the most useful of these compounds is dichlorodifluoromethane ( $\text{CCl}_2\text{F}_2$ ), commonly known as "freon" which is widely used as a refrigerant. It is ideal for this purpose and is rapidly replacing sulfur dioxide, ammonia, and methyl chloride in both household and commercial refrigeration. It is stable, non-poisonous, non-inflammable, non-corrosive and has very little odor. It is formed by the action of antimony trifluoride on carbon tetrachloride, using antimony pentachloride as a catalyst. The net result of this reaction is the replacement of two chlorine atoms in carbon tetrachloride by fluorine:



No doubt more fluoro compounds will find commercial application as research continues.

## The Newest Halogen

There has been a new arrival at the Halogen Family! In fact it is so new, very little is known about it.

In 1931, Allison and Murphy announced the discovery of what they

believed was element 85, "eka-iodine", later named *Alabamine*. However the element has since been made synthetically by bombarding bismuth with

alpha particles and has been re-christened *Astatine*. Much research must be done before definite properties of the new halogen are established.

## *Mass Spectrometer in Chemical Analysis*

➤ TINY LEAKAGES in systems built to hold gases are easily detected by the use of helium and a mass spectrometer, the American Chemical Society was told recently by Prof. T. I. Taylor of Columbia University, at a meeting at Hunter College.

The equipment to be tested is filled with helium gas. The mass spectrometer is placed at points which are suspected of leaking. If helium is escaping, its spectrum lines show up in the instrument. The helium used in this manner is called a tracer, and the method employed is called tracer technique.

Tracer technique is now widely coming into use in every branch of chemistry in which chemical reactions are followed in detail as they occur among isotopes. Recently relatively simple mass spectrometers have been developed especially for identifying isotopes rapidly and accurately.

Citing the importance of the mass spectrometer in petroleum chemistry, where it is used for rapid analysis of mixtures of many chemically similar compounds, Prof. Taylor declared that the instrument can be applied to the problems of almost any chemical process involving gases or substances that can be gasified.

## *Electronic Cleaning for Glass*

➤ CLEANING GLASS by bombarding it with electrons is something new. It is a method of preparing optical glass for television mirrors before the reflecting fine film of aluminum is applied.

This new optical-glass-cleaning process, which will have many other applications, is a development of Bausch and Lomb, engineers, one of whom described it at the recent meeting of the Optical Society of America.

The process is carried out in a vacuum. The ground and polished optical glass is placed in a metal holder within a high vacuum bell, and bombarded with electrons from a tungsten filament similar to those used in ordinary

electric lights. When the filament is heated by the electric current, the electrons are given off. Electrically, they are negatively charged particles, and they are attracted with force to the metal holder of the glass and to the glass.

Thus attracted, the electrons bombard the glass at a speed of several thousands of miles a second. They clean the glass of all moisture and other materials. After cleaning, the glass, still left in the vacuum chamber, is coated with aluminum by an evaporation process. In this, microscopic particles of the metal are evenly distributed on the glass in a very thin film.

**Chemicals for Many Purposes  
Devised by Today's Inventors**

## Patent Story of the Month

*Copies of specifications of patents issued may be ordered by number from the U. S. Commissioner of Patents, Washington 25, D. C. at twenty-five cents each. Send currency or money order but no stamps.*

### **Fluorine-Hydrogen Welding**

► A WAR-BORN METHOD for cutting and welding metals with flame that uses no oxygen is covered by newly-issued U. S. patent 2,421,649, assigned by its inventors, H. F. Priest of New York and Dr. A. V. Grosse of Marcus Hook, Pa., to the Office of Scientific Research and Development.

Cutting and welding copper with flame has presented peculiar difficulties, partly because as soon as copper melts it forms oxides that interfere with the work, and even more because of the high thermal conductivity of copper, which carries away the heat before it can make the cut or weld.

The two engineers use a unique combination of gases, fluorine and hydrogen, to get an oxygenless flame of very high temperature — about 4,000 degrees Centigrade. This readily cuts copper. It is also good for welding because of the instant formation of copper fluoride, which serves as a flux, protecting the metal at once against oxidation and the corrosive effects of the fluorine gas itself.

### **Reversing Gas Turbine**

► A REVERSING gas turbine in which the flow and temperature of the driv-

ing gases do not fluctuate during reversal is offered by C. R. Waller of Trenton, N. J., for patent 2,421,445. It is claimed to be peculiarly well adapted for use in ship propulsion. Patent rights are assigned to the De Laval Steam Turbine Company.

The principle involved is very simple. Driving gases are supplied through a ring of nozzles set at an appropriate angle for forward motion. There is a second ring, with nozzles pointed at an opposite angle. Both rings are movable; so to reverse, the "forward" nozzles are pushed out of the way, and at the same time the "reverse" nozzles are brought to bear. The turbine operates at lower efficiency in reverse, but that is a matter of relatively minor importance.

### **Malic Acid From Furfural**

► FURFURAL, that versatile chemical made from such agricultural wastes as corncobs and oat hulls, gets turned into almost everything nowadays. Newest are malic acid (the acid of apples) and its kin-compound, malic anhydride. They are produced by contacting furfural vapor at moderately high temperatures with a catalyst containing ammonia and its vanadium and molybdenum salts, preferably deposited on metal tubes. Patent 2,421,428, issued on this process to Erik R. Nielson of Chicago, is assigned to the Quaker Oats Company.

### For Oil Well Pressure

► To SPEED the recovery of oil from sluggish wells, Ralph M. Steffen of North Hollywood, Calif., explodes carbureted gases in a cylinder, and pumps them down the well while still flaming hot. The heat reduces the viscosity of the oil, and the pressure substitutes for the lost natural gas pressure. Patent 2,421,528 was granted on this idea.

### Syrups From Fruit

► SWEETENING SYRUPS are made from surplus fruits by grinding them up with water, making alkaline with lime, neutralizing with phosphoric acid, then filtering and clarifying the liquid. A. M. Erickson of San Jose, Calif., and J. D. Ryan of Campbell, Calif., have received patent 2,421,376 on this process.

### Rocket Developments

► TWO ROCKET INVENTIONS figure among recent patents. One, covered by patent 2,421,522, is by W. B. Pope of Detroit. A rocket is fired out of a recoil-less gun as if it were an ordinary shell. After it has completed part of its flight, rocket-propelling charges in its base begin to function, giving it additional velocity and range.

The other rocket invention, by C. L. Eksergian, also of Detroit, is a multi-jet missile intended for very high flight or long range. Rights in both patents are assigned royalty-free to the government.

### Machine Makes Metal Powders

► A MACHINE for making very fine metal powders is covered by patent 2,422,099, issued to Siegfried Hiller of New York. It might be described as a shot-tower in reverse, with furn-

ace attachments. A wheel covered with steel fingers, revolving in a closed chamber, dips into the surface of a pool of melted lead, tin, copper or other metal, flipping fine drops into an opening near the bottom of a cylindrical combustion chamber. The metal spray is blown upward, only the heavier drops falling back into the pool. The cooling metal particles may be drawn off as such, or may be reacted with chlorine or other gases to form compounds.

### Ore Separation Process

► INDUSTRIAL OPERATIONS that depend on separating light particles from heavy ones, such as ore flotation and coal sorting, are now offered the benefits of centrifugal force, long familiar in the cream separator. A machine embodying this principle, invented by H. L. McNeill of Denver, has just been covered by U. S. patent 2,422,203.

The mixture of light and heavy particles, as it comes from the grinding mill, plus water and whatever pulp is used to facilitate separation, is discharged into a conical or cylindrical chamber, within which a correspondingly-shaped rotor is spinning. Light and heavy particles, thrown outward from the rotor, form two zones, the lighter within and the heavier without. Heavy particles settle to the bottom and drop out through a central opening; light ones float to the top and find there an appropriate discharge spout.

### Fruit Paste

► FROM REHOBOTH, in troubled Palestine, comes a method for making dried fruit paste in leathery sheets, later to be soaked up and prepared

for the table. The outer rind is grated off citrus fruits, the rest ground to pulp and dehydrated. A little of the grated rind may be returned for flavoring if desired. This procedure, developed by Zdenka Samisch, is protected by patent 2,422,588.

### **Advances in Electronics**

➤ TWO IMPORTANT IMPROVEMENTS in electronic instruments are among the new U. S. patents.

One is a new type of viewing screen for use with electron microscopes, devised by Dr. Charles H. Bachman, physicist in the laboratories of the General Electric Company. For the fluorescent materials at present in use he substitutes a thin layer of potassium chloride crystals. This turns deep purple under the impact of even a weak electron bombardment, and holds its color for a considerable time. This makes greater image enlargement possible, also the making of photographic records without having to put the plate-holder into the microscope's vacuum chamber.

Dr. Bachman has assigned his patent, No. 2,422,943, to his employing firm.

The other instrument is an electronic analyzer, the work of Perry C. Smith, who is on the staff of the Radio Corporation of America. In it, electron beams are used very much as X-rays are, to produce patterns of rings or dots on photographic plates after passing through a sample of the substance to be analyzed. The patterns indicate the atomic composition of the material.

Previous instruments of this kind used electron beams of fixed diameter.

In Mr. Smith's device the electron beam can be changed in cross-sectional area by magnetic "lenses" like those used in electron microscopes. The patent, No. 2,422,807, is assigned to RCA.

### **Plane's Retractable Jets**

➤ JET-ASSISTED takeoff for planes advances a stride in the invention on which patent 2,422,744 was awarded to William F. O'Neil of Dayton, Ohio. The jet units are retracted into the fuselage or wing-cavity when not in use. They can also be pointed forward instead of aft, to serve as brakes in landing. Patent rights are assigned to the General Tire and Rubber Company.

### **Columbium Helps Copper**

➤ DR. ALAN U. SEYBOLT of the Battelle Memorial Institute, Columbus, Ohio, has found that the addition of 15% or less of the rare element columbium to copper and soft brass will help to preserve the hardness they acquire by cold-working even when exposed to temperatures that would ordinarily soften them again. His patent, No. 2,422,752, is assigned to the Electro Metallurgical Company.

### **Chocolate Alkaloid**

➤ THEOBROMINE, the alkaloid found in chocolate beans, is extracted by a distillation process on which patent 2,422,874 was issued to B. J. Zenlea of Ozone Park, N. Y. Theobromine has much the same physiological effect as caffeine, and is used medicinally for similar purposes.

### **Milk Spray**

➤ APPARATUS for spray-drying whole milk by squirting a jet of it into a swirling current of hot air, the in-

vention of George Tooby of Prentice, Wis., is covered by patent 2,422,706. Principal part of the apparatus is a large inverted cone, with an opening for discharge of the dried milk particles at its pointed lower end.

### **Rocket Designs**

► TWO DETROIT INVENTORS, C. L. Eksergian and W. W. Farr, have assigned free rights to the government to make and use rocket weapons

which they have devised, covered respectively by patents 2,422,720 and 2,422,721. Mr. Eksergian's rocket has a built-up motor consisting of any desired number of frustro-conic sections fitted together. This permits a wide choice of velocities and ranges.

Mr. Farr's invention is a closure for the open rear end of a rocket, with venturi openings so placed as to impart a spinning motion when the propellant gases pass through them.

## *Carbon Monoxide Detector*

► DANGER from carbon monoxide poisoning can be avoided by use of a simple, relatively inexpensive method developed by the National Bureau of Standards that will indicate by color as little as one part of the dangerous gas in 500,000,000 parts of air.

It was developed for determining the amount of carbon monoxide within aircraft, but can be used to equal advantage in busses, automobiles, garages, furnace rooms, and other places where this gas may lodge from incomplete combustion in engines or stoves.

The color indicator used in this new carbon monoxide detector is a yellow silica gel impregnated with a complex silicomolybdate compound and catalyzed by means of palladium sulfate. This mixture is placed in a five-inch glass tube the size of a lead pencil, and air to be tested is forced through. The yellow indicator turns green if carbon monoxide is present, the degree of green indicating the amount of the poisonous gas.

In use the sealed ends of the glass tube are broken open and one end of the tube is inserted in an ordinary

two-ounce rubber aspirator bulb equipped with a special control valve. The bulb is squeezed once, then the color of the gel is compared with a set of standard color chips. A test can be made by an untrained person in about one minute.

The Bureau does not claim full credit for this carbon monoxide indicator. In 1941, the English Royal Air Establishment developed a similar device but it was not sensitive enough to have full value. The National Bureau of Standards, starting with the British material, produced an indicator four times as sensitive, more adaptable to field conditions, and truly colorimetric.

While information concerning this wartime development is only now revealed, over a half million sets were produced by the Bureau and used during the war by American, Canadian and British military services. Patents have been issued on the device and assigned to the Secretary of Commerce. The new method will undoubtedly replace earlier and more expensive processes for determining the presence of the odorless, colorless carbon monoxide that takes many lives in America each year.

### Three Kinds of Synthetics Make Satisfactory Brushes

## Brush-off For Bristles

*Reprinted from the Industrial Bulletin of Arthur D. Little, Inc.*

► WHEN THE WAR cut off the supply of Chinese hog bristles, a variety of materials were tested for use in paint brushes. Some served only as stop-gaps, but three—casein, cellulose acetate, and nylon—show promise for permanent acceptance. All of these new brush filaments are made from domestic raw materials, a great advantage for the manufacturer of paint brushes, since the market for hog bristles is highly speculative. Furthermore, long bristles come only from hogs five years or more old. If, in improving Chinese agriculture, these hogs should be replaced by other varieties which mature much more quickly, good bristles could no longer be had. This has already happened in Russia. Long bristles are less plentiful and hence more expensive than short ones; cost of the new synthetics does not depend on length, hence they have the greatest cost advantage in brushes requiring long bristles.

A mixture of casein and water can be extruded and set into filaments of any desired length or diameter; these filaments are remarkably resistant to oils and organic solvents. Brushes of casein filaments are not as strong or water-resistant as brushes of hog bristle, but they are less expensive, especially in comparison with long bristle. Bristle approximately four inches long has varied in price during the past four years from \$5.85 to \$14.50 a pound. Bristle brushes wear out rapidly, and large contractors find that

brush costs may be ten cents or more per man-hour. Hence there is believed to be a demand for a more economical brush, which the casein product should be able to meet. The Rubberset Company, largest U. S. manufacturer of paint brushes, has recently opened a pilot plant for the development of casein filaments and brushes. Casein is derived from waste skim milk, but the Department of Agriculture is looking into other sources.

Cellulose acetate, another synthetic material, can be used in conventional oil-base, water-base, or water-emulsion paints, although it is soluble in lacquer solvents. Manufactured by the Pittsburgh Plate Glass Company under the trade name, "Neoceta," its use is expected to outlive the wartime shortage of bristles. The paint-carrying capacity of brushes made of Neoceta is said to be superior to that of natural bristle.

Nylon brush filament equals natural hog bristle in most qualities and surpasses it in some respects. Early nylon brushes were less satisfactory than bristle brushes in paint-carrying capacity and general handling characteristics. To improve these qualities, the Rubberset Company made a detailed study of the factors which influence brush quality. Traditionally, this has been judged simply by the reactions of the individual painter. Methods were developed for measuring quantitatively the important characteristics of good brushes, and several devia-



tions from accepted theory were discovered. For instance, most authorities believed that a paint brush is normally held at an angle of 45° to the work, but high-speed photographs revealed that the handle is actually perpendicular to the paint surface. With the fundamental information thus acquired, it was possible to analyze nylon's shortcomings and largely to overcome them. An example was the superior paint-carrying capacity of natural bristle; after several theories were tested, it was found that hog bristles had a natural "wave." These waved bristles made a bushier brush, containing voids which held large

quantities of paint. Production of a waved nylon filament, with a proper distribution of lengths and diameters, resulted in a brush with as good paint-carrying capacity as the brush made of natural bristle.

Although some problems remain to be solved, such as nylon's susceptibility to the alcohol used as a solvent for shellac, and manufacturing difficulties in making tapered bristles of the desired contours, the nylon brush is now widely sold in competition with hog bristle. The nylon brush costs less and, even more important to the painter, wears at least five times as long as a high-quality bristle brush.

## *Plastics Now Flame Sprayed*

► PLASTICS MATERIALS have many little-known uses ranging from water softeners and purifiers to adhesives for joining almost any types of materials. Dr. Paul O. Powers, of the Battelle Memorial Institute, Columbus, Ohio, told the Chicago section of the American Chemical Society. Some plastic products are fast-drying printing inks and others are better lubricating oils.

Plastic products, he said, are largely associated in the public mind with gadgets and bright-colored moulded articles familiar in everyday life. But plastics can be tailored for innumerable other applications because they are composed of very large molecules whose structure can be varied as desired.

A new flame spraying process makes it possible to apply a fine plastic film on an object as a protective coating without the use of the customary solvent. Usually solvents

are required. They are expensive and large volumes are needed because otherwise plastics form a very thick solution.

In the flame spraying process, the finely divided powdered plastic is blown into a hot flame which softens the material and applies it to the surface to be coated. Other methods have been developed which use low-cost solvents by suspending rather than dissolving the plastic material, fusing the resin particles after application to obtain a continuous film.

Dr. Powers mentioned also plastics developed from silicon, the element present in sand, which are remarkably stable at high temperatures. He described a plastic made from fluorine, the unruly gas which has been tamed by wartime research, as characterized by high resistance not only to heat but also to solvents and chemicals of all types.



# Chemical Things To Do

## See Your Own Voice

by JOSEPH H. KRAUS

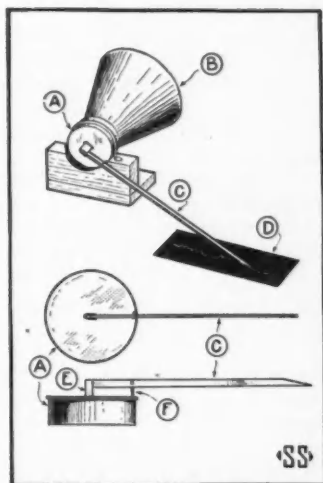
► WOULD YOU LIKE to see your own voice?

Sound is nothing more than disturbance of the air (or other material) caused by vibrations. These vibrations travel through the air in much the same way that ripples move across the surface of a pool of water.

The phonograph works because these sound waves have been "caught" in the record, the tiny waves characteristic of the sound being impressed either on the sides or at the bottom of the grooves. When the phonograph needle travels in these grooves, the wavy pattern causes the needle to communicate this motion to a diaphragm where the original voice or music is reproduced.

The first recording of sound was a tracing of sound waves on smoked paper. This was done even before Thomas A. Edison invented the phonograph, the first machine capable of reproducing human sound. You can see what your own voice looks like when recorded in this manner.

For this experiment you will need a smoked surface on which to make the wave pattern and a long "pen" with a pointed end to mark on the paper. This stylus must be attached to a diaphragm or disk flexible enough to vibrate in such a way that the stylus will move from side to side when someone speaks into the mouthpiece attached to the diaphragm. All of these can be made from easily-available material.



A round cardboard box, such as a pill box, about  $2\frac{3}{4}$  inches in diameter, can be used to support the diaphragm, which is made from a sheet of glassine or wax paper. Either the top or bottom half of the box may be used.

About an eighth inch in from the edge of the box, cut out the center, leaving a narrow band to which the diaphragm may be attached. Apply mucilage or cement to the narrow edge and lay the coated surface down upon your sheet of glassine or wax paper. Pull the paper gently until the diaphragm is stretched tightly like a drum over the pill-box opening.

### Make a Horn

When the diaphragm is dry, make a horn (B in the diagram) of stiff paper. It should be rigid enough not to vibrate when you speak into it. The diameter of the smaller end of the horn should be about  $2\frac{3}{4}$  inches so it will fit the pill box. Attach the horn to the end of the box with gummed paper or cement.

The recording stylus (C), cut from discarded X-ray film, is at least 14 inches long and  $\frac{3}{8}$  inches wide. To make it more rigid, fold the strip of film along its entire length to make a trough. Be careful not to make the fold so sharp that the film cracks. Cut the end of the stylus to a long, tapering point.

The upright (E) is another piece of film folded in the same way. Cement the two together at right angles, placing the recording stylus inside the upright. Ordinarily celluloid or airplane cement is excellent for the purpose.

Rest the upright lightly on the middle of the diaphragm and hold the stylus above the diaphragm and parallel with it. Cut off the end of the upright so that the stylus will be about  $\frac{1}{8}$  inch above the box.

### Make Support for Pen

Push a pin through the stylus near the fold and far enough from the upright for it to be almost in line with the edge of the box. Your pin should go through both thicknesses of the stylus. About  $\frac{1}{8}$  of an inch from the head of the pin, bend the pin at right angles, making an inverted L, and

push it into the rim of the box as shown in the diagram. Cement the upright to the middle of the diaphragm and cement the pin to the box.

Fasten the sound recording device you have just made to a block of wood, with the edge of the box on the wood, as shown in the diagram, or hold it on a pile of books directly in front of the loud speaker of your radio. Turn on the radio as loud as you can and watch the stylus vibrate.

### Use Smoked Glass

Either smoked glass or smoked paper may be used for recording these vibrations. Hold a sheet of glass above the flame of a candle. To get an even coating of black soot, move the glass rapidly back and forth, as close to the flame as necessary to coat it with soot. Now be careful not to touch the smoked side. Place the glass, black side up, on the table and adjust the recorder until the tapered point of the stylus rests on the blackened surface. Turn on the radio and slowly move the glass under the stylus, being careful always to pull the glass in a straight line in the same direction. The changes in sound will be recorded in a wavy pattern on the glass. The pattern will be different for each musical instrument, or for singing or speaking.

Now try talking or singing loudly into the horn while a friend moves the smoked glass. The wave form of your own voice will not be as pronounced as for a radio broadcast, but it will have its own distinctive pattern.

Radiant heating in homes, from heating pipes laid in concrete in the floors and sidewalls, is replacing more conventional types of heat distribution because of its efficiency, economy and cleanliness.

## Gasoline From Oil Shale Enters Federal Commercial Production

# Oil From Shale Demonstrated

► SOME 92 BILLION barrels of oil bedded within America's oil shales will soon begin to take its place in the nation's liquid fuel supply.

A dribble of 1,200 to 2,000 gallons a day will be obtained from the government's new \$2,000,000 demonstration plant near Rifle, Colorado. This first commercial production in the United States is intended to show what can be done.

Gasoline from oil shales has been produced for several years in various countries. Production from this source has been delayed in America because natural petroleum was plentiful. This plant is one step in the government's program to assure America a plentiful supply of liquid fuels even if natural petroleum deposits are exhausted. Other steps include the production of oil from coal and lignite, and alcohol fuels from farm products, particularly farm wastes.

This government demonstration plant, which is in part experimental, is located on the U. S. Naval oil-shale reserve in a region in which more than half the nation's entire oil shale is found. About 15 gallons per ton of shale is expected. It is estimated that there are 300,000,000 barrels per square mile.

The extraction of oil from oil shale is a relatively simple process. It is costly, however, because the shale must be mined, carted to the plant and crushed before processing. It is put into giant retorts lined with firebrick where it is heated enough to

drive the oil off in vapor form. This vapor is collected, condensed, and then refined much as natural petroleum is processed. Waxes and lubricants are obtained as well as the fuel.

Most oil shales are hard, slate-like rocks with greenish-brown veins of greasy material. Mining here is a relatively easy job because much of the shale crops out on mountain slopes, and the mining shafts can be driven horizontally into the mountain sides. In other sections of the country much of the shale is underground and must be brought to the surface by shaft elevators.

In Sweden, oil is being obtained from underground shale by heating the material where found by means of electricity. Electric heaters are lowered into the shale beds through bored holes and, after months of heating, the vapors arise through these and others. The process is reported successful, but it seems to be practical only where electrical energy can be obtained without fuel-consumption, as by waterpower.

In addition to Colorado's oil-shales, there are deposits in Utah, California, Kentucky and Indiana. California's shales yield a true petroleum that can be dissolved out with solvents of the naphtha type. They yield about 20 gallons to the ton. Kentucky-Indiana deposits are underground but near enough to the surface to be recovered by strip-mining. Tests indicate they will yield about 16 gallons per ton of rock.

**Native Lands of Discoverers  
Honored in Naming New Metals**

## Two More Group III Metals

### Classics of Chemistry

*The original reports of discovery of two of the three elements which Mendeleeff had predicted are reprinted here. Gallium is Eka-aluminum, Scandium is Eka-boron. The great Russian chemist predicted the properties of all the elements that he could spot as missing from his Periodic Table, but these two, together with Eka-Silicon (Germanium), were the first of his predictions to be verified.*

## Gallium

SUR UN NOUVEAU MÉTAL, LE GALLIUM, par M. Lecoq de Boisbaudran. *Annales de Chimie et de Physique* (5) X, 100. 1877. Translated for CHEMISTRY by Helen M. Davis.

► GALLIUM has been discovered too recently for its study to be well advanced. By reason of the excessive rarity of the new element in the first material examined up to now, the time elapsed since the determination of its existence has been principally given up first to research upon a practical method of its extraction, then to the treatment, always long in a small laboratory, of many hundred kilograms of the mineral; finally to the even more complicated purification so that the manner of gallium's behavior with many reagents is still unknown.

I can only give here a very incomplete account of gallium. This glimpse may nevertheless be sufficient, I hope, to serve as a basis for researches which other chemists may wish to undertake.

### History

Ever since I have been interested in chemistry, my attention has always turned to the philosophical question of classification of the elements. Interesting relationships have already been pointed out by many scientists (in particular by M. Dumas) between the atomic weights of certain simple substances and the properties which have led chemists to group these substances into the same natural family.

I have devoted myself to seeking new relationships between the comparison of the atomic weights of the elements and certain of their properties: such, for example, as the emission at high temperatures of luminous rays of definite wave-length. I have thus found relationships hitherto unknown and I have drawn from them some deductions which seem to me rather curious.

These ideas were in part set down in the sealed communication deposited with the secretary of the Institute, and I had the honor of presenting a

few more in detail before some illustrious chemists, chiefly in conversations with M. Dumas and with M. Friedel.

Among the conclusions which have been drawn from my attempts at chemical classification appears the probability of the existence of unknown elements coming to fill the places left empty in the natural series.

It is clear that the position thus occupied in a chemical family by an hypothetical element shows approximately the properties of that substance.

But speculations of this kind are always tainted with a certain uncertainty. Also, in spite of the importance which I cannot help but attach to hypotheses born of my imagination, I have never thought I ought to publish them without having submitted them to the control of experiment and without having made serious efforts to make them produce positive results, which confirm them at the same time that they allow them to develop by correcting and fixing the ideas.

The actual perfection of chemical analysis and the care with which nearly all the known minerals have been examined, gives scarcely any hope of finding new elements, as they would have been found already, in the substances of which they would form an essential constituent part; it is necessary to pay attention to those which are met with only in the state of faint traces disseminated through considerable masses of unknown substances.

The uncertainty which inevitably rules over the *exact* chemical reactions of a hypothetical substance, defined solely by its position in a natural

series, makes fairly uncertain a unique success founded upon the direct application of those reactions *calculated in advance*; for the least error in foreseeing one of these could throw the substance sought out of the analytical place to which theory assigned it.

The difficulty seems to me very great. To obviate it, I have imagined a particular course of mineral analysis, such that making an error, whether about the properties of the substance sought or about those of known elements, would not invalidate the final results.

By its extreme sensitivity, spectrum analysis is a great help in this kind of work; but nevertheless, it does not constitute an essential and indispensable part of my method of research; only, it is a marvelous tool whose power it is necessary to use and to whose perfecting I have, besides, devoted long years. I believe that spectrum examination of quantities so faint as the solution in which I have established, for the first time, the existence of gallium would have been unapproachable before the modifications which I have made in the apparatus for producing electric spectra. My designs, *carried out under well-determined experimental conditions*, have been equally indispensable to guide me among the numerous lines which form the spectra of the metals.

My first attempt at research upon the new simple bodies dates back now about fifteen years. At that time I did not possess a laboratory and I had the use only of entirely inadequate apparatus. This attempt, which was carried out upon a considerable quantity of material, had to be abandoned before

its completion; the greater part of the products which were detected in it were lost. In 1863 I was able to construct my real laboratory and I was able to equip it a little better. I renewed my attempts and I made many series of researches, but without any success. Evidently I had therefore employed too little material. These experiments were, nevertheless, not entirely useless, for they allowed me to complete and to perfect a little the method by which I am continuing to work in the hope of publishing it some day.

Finally I decided to work on a larger scale, as I had done at the beginning of my researches, and, in February 1874, I began the treatment of 52 kilograms of the blende of Pierrefitte, set aside for that purpose in the fall of 1868.

On the 27th of August 1875, between 3 and 4 o'clock in the afternoon, I found the first indications of the existence of a new element, which I have named "gallium" in honor of France (Gallia).

### Properties of Pure Gallium

Gallium is a gray-white metal, having a beautiful luster, but becoming tarnished quickly in humid air on account of superficial oxidation.

The color and the sheen are notably modified at the moment when the metal solidifies. In the liquid state (in superfusion, for example), it is a very beautiful silver white; but, if a point on its surface is touched with a bit of solid gallium, one sees a spot form which extends itself rapidly: it is the metal which, in crystallizing, takes on a very pronounced bluish color; at the same time the brilliance diminishes.

Gallium melts at the heat of the hand.

In a first experiment, made in April 1876, the point of fusion was found between 29 and 30 degrees, so it was placed at about  $+29.5^{\circ}$ .

I have repeated this measurement on six samples of gallium, deposited successively from the same solution without disturbing the apparatus. Under similar conditions the presence of strange metals shows itself by differences in the melting point of different samples collected.

		Point of fusion
Gallium No. 1		$30.14^{\circ}$
" No. 2		$30.16^{\circ}$
" No. 3		$30.14^{\circ}$
" No. 4		$30.15^{\circ}$
" No. 5		$30.16^{\circ}$
" No. 6		$30.16^{\circ}$
		<hr/>
		$30.16^{\circ} (1.)$

Once solidified, gallium is hard and resistant, even to a few degrees above its point of fusion; it can, nevertheless, be cut, is flexible and malleable.

Above  $30.15^{\circ}$ , or in the cold when supercooled, gallium wets the glass and spreads over it, easily forming a beautiful mirror which seems to me to be whiter than that produced by mercury. On contact with tepid water gallium can easily be detached from the glass by rubbing.

The surface of the metal upon fusion is soon covered with a thin

(1.) As it is so difficult to determine the precise instant when the little masses of gallium give the first signs of fusion, I think that  $+30.15^{\circ}$  is rather too high by some hundredths of a degree than lower than the true point of fusion.

skin of metallic appearance, but doubtless formed of the oxide, under which is seen a little mobile stream when the flask is tilted.

Heated to bright red in the presence of air, gallium does not volatilize and is oxidized only very superficially. After cooling, it is sufficient to rub the metal with a rod to restore its luster.

If platinum foil covered with gallium is heated to redness, the latter

element penetrates a little into the foil and begins to alloy with it, for hydrochloric acid no longer attacks it; it is nevertheless dissolved by aqua regia so weak that it will dissolve only traces of platinum. At the same time, a thin white skin is detached, formed probably of the oxide of gallium which calcination has rendered difficultly soluble in acids. The solution in aqua regia gives the spectrum of gallium.

## Scandium

SUR LE SCANDIUM, ÉLÉMENT NOUVEAU. *Note de M. L.-F. Nilson, présentée par M. Berthelot. Comptes Rendus 88, Jan.-Jun. 1879, p. 645. Translated for CHEMISTRY by Helen M. Davis.*

► THE PREPARATION of ytterbium, described in the preceding Note, gave me an earth described as an insoluble sub-nitrate; upon again testing the mass heated with boiling water, it was found that the molecular weight was, not 131, as it should have been from M. Marignac's calculation, but 127.6. I concluded from this that an earth showing a molecular weight less

than 131 must be mixed with the product examined. M. Thalén, who has had the kindness to examine the spectrum, having found that the chloride of this substance showed some lines unknown for the elements described above, I had to try to isolate this substance. Toward this end, I made many partial decompositions of the nitrates and some determinations of the molecular weights of the earths deposited in the insoluble residues and containing the new material, following the methods indicated in my note on ytterbium. The results are shown in the following table.

Serial numbers of the decompositions	Weights of the earth deposited gr.	Determinations of molecular weights of the earth		
		Earth weighed	Sulfate obtained	Mol. wt. for RO
13	3.5	( 1.0238 ( 1.0302	1.6656 1.6758	127.62 127.66
17	1.4	0.7070	1.1679	122.72
19	0.73	0.7135	1.2014	116.99
20	0.53	0.5129	0.8765	112.85
21	0.35	0.3298	0.5791	105.83

After the last series of decompositions, the molecular weight had been brought down 26 units below the

number 132, which belongs to ytterbium; but nevertheless the product examined was still mixed with this earth



as an impurity. With the impossibility of making again one or more partial decompositions of the nitrate in order perhaps to obtain the new substance perfectly pure, I had really no need to do it to prove that the oxide of an element hitherto unknown was mixed with the ytterbine, for the spectral lines of the substance, examined even while contaminated with ytterbine,

show sufficient evidence of the character of a true element: this appears in the following Note from M. Thalén:

In the spectrum research on a new earth separated from erbine by M. L.-F. Nilson, I have found the following lines, belonging to the spectrum of this material. The numbers below indicate, in millimeter measure, hundred-thousandths of their wave-lengths:

Color of the lines	Wave-length	Intensity	Remarks
Orange	{ 6078.5	3	Wide and diffuse
	{ 6072.5	3	
	{ 6054.0	5	Diffuse
	{ 6035.0	2	
	{ 6019.0	4	Diffuse
Yellow	{ 5736.0	6	
	{ 5729.0	6	Very fine and clear
	{ 5719.0	4	
	{ 5710.5	4	
	{ 5700.0	4	
	{ 5686.0	4	
	{ 5671.0	4	
	{ 5657.5	4	
	{ 5526.0	2	Strong
Green	{ 5089.0	6	
	{ 5084.5	5	Fine
	{ 5082.3	4	
	{ 5081.0	3	
	{ 5030.0	3	
Blue	{ 4742.5	3	
	{ 4739.0	4	
	{ 4736.5	5	
	{ 4733.0	5	
Indigo	{ 4404.0	5	
	{ 4373.0	5	
	{ 4323.0	5	
	{ 4319.0	5	
	{ 4313.0	5	
	{ 4245.5	5	

Lacking the light of the sun, it was impossible to determine the weakest lines. Besides these lines, I have observed many others which are found in the spectrum of ytterbine and which have hitherto been shown in the spectrum of erbine prepared by M. Höglund.

In this research I have used the Ruhmkorff induction apparatus (large model), eight Bunsen elements, two Leyden jars, two prisms of flint glass (of 60 degrees) and the large spectroscope which I have described before. To determine exactly the position of the lines of

the two substances, ytterbium and the new element, I have used two exciters, placed in front of the slit of the spectroscope, which was provided with a small prism; in this manner it is easy to compare the two spectra, placed one above the other, in the field of vision of the telescope. The registering in the solar spectrum was done some days in advance, the 7th and the 10th of March; I think, therefore, that the determinations of the lines can differ only by very little from their true position, although I have claimed only approximate determinations.

Rob. Thalén

Upsala, 11 March 1879.

### Name Proposed

For the element thus described, I propose the name *scandium*, which will recall its presence in gadolinite or in euxenite, minerals which have been found only in the Scandinavian peninsula.

As to its chemical properties, I can only say at present that it forms a white earth, whose solutions show no absorption bands; that the calcined earth is attacked only slightly by dilute nitric acid, even when boiling, more easily by hydrochloric acid; that it is completely precipitated by oxalic acid from the solution of the nitrate; that the salt is decomposed very easily, completely, apparently, at the same temperature as the nitrate of ytterbium is transformed only partially, into the subnitrate; that it gives with sulfuric acid a salt unalterable at elevated temperatures, under the same circumstances as the sulfates of the metals of gadolinite and cerite; that the sulfate, as with them, can be completely decomposed by calcination with ammonium carbonate. The atomic weight of scandium = Sc,

calculated for the formula ScO of the earth, is less than 90, because the purest earth examined in the spectroscope still retained a little ytterbium. Nevertheless, all the lines of this product show up very clearly, and some among them which have not been observed, being characteristic, one can conclude from this only that the atomic weight of scandium will not be notably lower than the minimum which has been attained at the moment.

It would certainly be premature to discuss the affinities of the new substance or its place among the other elements; but I cannot help making some observations along this line, as to its chemical properties known at the present time.

The nitrate of scandium is decomposed so easily by a rise in temperature, that nearly pure ytterbium has been obtained by the decompositions 13-21 of the preceding Note, so that if scandium is deposited completely in the insoluble residue, it is not possible that the oxide has the formula ScO. The composition of this earth does not show more analogy with that of ytterbium (formula  $\text{Sc}_2\text{O}_3$ ), and it cannot belong to the group of metals of gadolinite, because the nitrates of those metals are decomposed the more easily as their atomic weights become greater, or the basicity of the earths especially is greater as the molecular weights become less. It remains therefore only to admit that the earth scandium should have the formula  $\text{ScO}_2$  and that scandium ought to be placed among the tetratomic metals. Its place should then be between tin and thorium, and its atomic weight, comprised between 160 and 180, to fill the space

which hitherto existed between the atomic weights of those two elements, 118 and 234.

The earth from which I extracted scandium had its origin in two minerals, gadolinite and euxenite. M. Marginac having observed only a continuous augmentation of molecular weight of the earth which he has extracted from gadolinite, I should have been inclined to assume that scandium occurs solely in the other mineral if M. Thalén had not made the interesting observation that one spectrum line previously common to erbium and ytterbium prepared by means of gadolinite, belongs to the spectrum of scandium without being visible in that of ytterbium. Since M. Clève took 10 kilograms of gadolinite for his work and will soon allow me to treat

an equally great quantity of euxenite, it may be presumed that this question will soon be solved.

I shall end this Note by expressing to M. Thalén my appreciation for his researches on the spectrum made upon the products yielding scandium. Having still at my disposal only a very small quantity of this material, which, obtained from ytterbium, gave perhaps only 0.25 of the earth, I should not have been able, without his powerful cooperation, to demonstrate today the existence of a new element. Consequently I hope soon to be able to deliver to him the pure chloride of ytterbium as well as of scandium. Science can then thank M. Thalén for a complete study of the spectra of the two recently discovered elements.

To meet war food needs, Great Britain has increased its production of fertilizers, including sulfate of ammonia, agricultural lime and basic slag.

A single cork tree in California 73 years old yielded 1050 pounds of cork in one stripping; it is now growing a second crop.

## Unbalanced Equations

### Housing Solution

► "WITH THE OLD cyclotron of 225 tons, we could knock two or three floors off a 50-story building, or maybe add a floor or two. But with the new cyclotron, we can knock that 50-story building into a flock of four-room bungalows, with a lot of nails and shingles left over."—University of California scientist quoted by both *Time* and *Newsweek*. (For what really happened, see CHEMISTRY, this issue, pages 1-2.)

ite,  
ion

ing  
his  
up-  
um.  
y a  
ial,  
ave  
, I  
out  
on-  
ele-  
be  
lor-  
an-  
M.  
the  
red



➤ *DESENSITIZATION SHOTS given to soldiers help them get through the hay fever season with less discomfort. The new chemicals can be given in this manner.*

## Chemical Relief for Hay Fever

by JANE STAFFORD

➤ MOST OF THE nation's 3,000,000 hay-feverites, whether they know it or not, have been playing the role of scientific guinea pigs this summer. Many of them have had a happier, less sneezy summer than ever before.

The reason: Chemists have developed a number of weapons for fighting the annual crop of sneezes, sniffles and general misery that starts with the first wind-tossed tree pollens in

March and drags on until frost kills off the ragweed in the late fall.

Chief of the new chemicals are pyribenzamine, antergan also called 2339 RP, and benadryl. Any day now, there may be some others, because chemists and drug manufacturers are still busy creating new anti-hayfever and anti-allergy weapons.

### New Weapons Tested

Pyribenzamine, antergan and benadryl (sorry, but those are the simplest

names for them) were tried to some extent last summer. They had previously been tested on relatively small groups of patients with hayfever and other allergies. These tests showed the new drugs to be pretty effective. From 82 per cent to 95 per cent of the patients were said to have had their symptoms relieved. Doctors and patients were enthusiastic. Then came the ragweed season. Ragweed can cause more trouble than practically any other substance that causes hayfever or other allergies.

The new drugs did not give relief to the extent observed in the studies on small groups of persons, states the editor of the *Annals of Allergy*, official journal of the American College of Allergists.

Hayfever patients with mild symptoms got good results but these patients are often relieved by sedatives, hot drinks or rest.

"Some patients with a moderate amount of hayfever have done well but the results are not consistent," the editorial continues. "Some days the drugs have blocked symptoms, other days there has been no response. This has probably been due to the fact that there is a tendency to great fluctuation in the pollen counts. When they are high, more drug is necessary, and when they are low, less is necessary; but if the patient forgets to make this decrease in dosage, then side reactions are apt to occur. This feature alone makes use of the drug impracticable in some individuals.

"Severe cases of hayfever benefit very little from the anti-histaminic drugs. Often there is a tendency to increase the dosage until levels twice

those recommended are reached. These large amounts of benadryl and pyribenzamine are apt to cause side reactions in so many instances that a recent study, which will soon be published, reveals that four out of every five subjects had unpleasant results leading up to a discontinuance of the drugs."

The unpleasant side reactions were nausea, vomiting, headaches, disorientation and drowsiness. About one-fourth of the patients had such trouble with the drugs. As a result, there is considerable confusion as to the merits of the drugs and the basis for their use, the editor points out.

Some of the confusion comes from the fact that the drugs were introduced as anti-histamine chemicals. The theory behind this is that the primary cause of allergic reactions, such as hayfever, hives and so on, is the release of histamine, a chemical normally present in body tissues. Authorities do not agree on this theory, and some question whether pyribenzamine and benadryl give relief because of their anti-histamine actions or because of some other action, such as their sedative effect.

"One ray of hope" is offered by the editor of the *Annals of Allergy*. This is to combine the new drugs with the old-established desensitization or immunization method of treating hayfever. By this method, patients are given tiny, gradually increasing doses of an extract of the pollen that causes their hayfever. The idea is to get their bodies used to the offending substance before the season starts. Most patients with mild and moderately severe hayfever are helped by

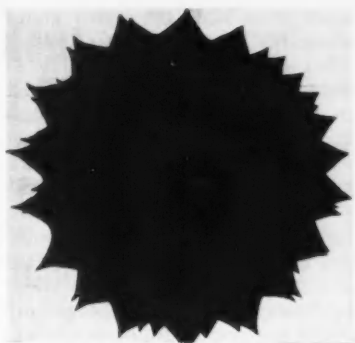
this. The ones with more severe hayfever often are not. They are so sensitive to the ragweed pollen that when the desensitizing doses are increased, they get severe reactions to them and not enough can be given to finish the desensitizing job. Benadryl and pyribenzamine, however, control these reactions. So they might be used to help make the desensitizing procedure a success even for patients with severe hayfever.

It will take another hayfever season or two, the *Annals of Allergy* editor states, before the new drugs are finally evaluated. So hayfeverites this summer can expect to be guinea pigs for this evaluation, and many of them will probably be relieved of much of their misery in the process.

Giving the chemicals to the weeds instead of the patients is another modern way of fighting hayfever, particularly the kind due to ragweed. This is one of the peacetime benefits we can have from our biological warfare research which included potential chemical warfare on food crops as well as germ warfare on humans and domestic animals.

The new weed-killer, 2,4-D, which was studied in these researches, can be a peaceful weapon to free millions of hayfever sufferers now and in the future. All that is necessary is to lay down a fog of this chemical on roadsides, empty lots and other areas infested with ragweed, the chief cause of hayfever. The fogging, when done at a very early stage of flower development, will kill the plants before they shed any pollen.

While this is a measure for community hayfever fighting, there are



➤ RAGWEED POLLEN spore as it appears to the electron microscope.

a number of things the hayfever sufferer can do and avoid doing which will add to his comfort during the pollen season. His doctor will tell him about these, but repeating them here may help patients who are forgetful.

Before the desensitization treatments were used, hayfever sufferers found their only relief by going away during the pollen season to regions free of the troublesome pollens. Those who had to stay at home found that it helped to keep doors and windows closed. Undisturbed by drafts and breezes, the pollen grains settled to the floor and caused less trouble. Mechanical devices in windows to filter the pollens out of the air of the patient's sleeping room are also helpful enabling him at least to get a sound night's sleep. Filters like those used in modern gas masks should be helpful.

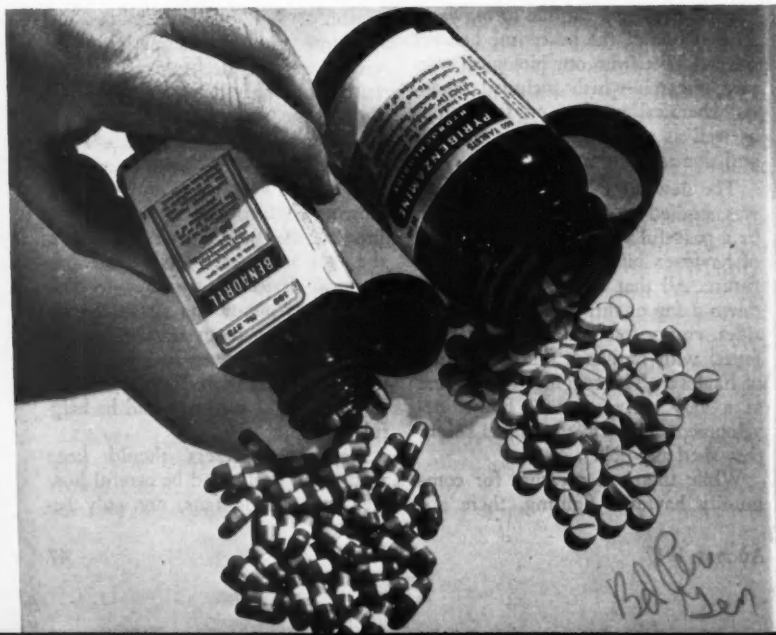
Hayfever sufferers should keep away from drafts and be careful how they use electric fans, not only be-

cause these blow the pollen grains about but because of their chilling effect on the body. The ability to react to chilling processes is altered in hayfever sufferers. In them, loss of body heat causes an abnormal swelling of tissues in the nose, with consequent constant sniffing and sneezing. People who do not have hayfever may occasionally experience this sneezing or stuffiness of the nose after a sudden drop in temperature, for example on going into an air-cooled store or theater on a hot day. To the healthy person the nose stuffiness, if he does feel it, is only a temporary and minor discomfort. To

the hayfever sufferer it may mean 24 or 48 hours of severe discomfort. Air-conditioning, which keeps the air free of pollens, will help the hayfever sufferer, but air-cooling is likely to cause trouble. Electric fans should not blow directly on the hayfeverite and should not be used to cool the air to the point of chilling his body.

Iced drinks are also likely to cause trouble for hayfever sufferers because of their chilling effects. Hot drinks, on the other hand, are recommended by one authority who states that they are especially helpful when taken soon after awakening in the morning.

► *NEW CHEMICALS whose ability to help hay fever sufferers is being tested this summer. Variations in the way patients react to them may teach doctors more about allergies.*





## NOW each student can have his own copy of CHEMISTRY

If you are a TEACHER, CLUB LEADER, GROUP LEADER, order CHEMISTRY in quantity! Science Service now offers to schools, industries, and science organizations the CHEMISTRY BUNDLE ORDER PLAN available for orders of 10 or more copies to the same address. Special quantity rates of \$1.25 for 9 months or \$1 for 7 months make it possible for every student or club member to have this valuable reference magazine. From front cover to back cover, CHEMISTRY explains the chemical world of to-day and what to look forward to tomorrow!

*Use this convenient coupon or write us a letter.*

---

### BUNDLE SERVICE ORDER BLANK (10 or more copies)

**To CHEMISTRY—1719 N St. N. W.—Washington 6, D. C.**

Please send me ..... copies of CHEMISTRY in one bundle  
each month (date)..... through.....  
9 months at \$1.25 each.                      7 months at \$1.00 each.

\$..... enclosed.

Send bill.

Address monthly BUNDLE to: (Please print)

Name \_\_\_\_\_

Address \_\_\_\_\_

City, Zone, State \_\_\_\_\_

CB-10

